Indirect Community Repercussions of Gun Violence: A Retrospective Cohort Study to Determine the Effect of Mass Shootings in the United States between 1982 and 2002 on the Birth Weight of Newborns

By:
Garrett Devenney
April, 2016



Allegheny College
Biology Department
Program of Global Health Studies

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A Senior Comprehensive Project in Partial Fulfillment of the Requirements for a Bachelor of Science Degree from Allegheny College

I hereby recognize and pledge to fulfill my responsibilities as defined in the Honor Code and to maintain the integrity of both myself and the College community as a whole.

_____

Pledge

Approval by the Senior Thesis Committee:

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Dr. Rebecca Dawson

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Dr. Kenneth Pinnow

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I would like to thank my *parents* for granting me the opportunity to attend Allegheny College. You have both been extremely supportive over the years, both academically and in my extracurricular activities, and wonderfully accommodating with undesirable urge to travel. Thank you for allowing me to pursue my dreams and believing in me every step of the way. I also owe credit to my *grandparents*. Grandma and Pap Devenney, thank you for the much needed Spring Break release in Florida and for being the best listeners. Grandma and Pap O'Connor, I do not think you missed even one of my swim meets during my entire career. I cannot thank you enough for your unwavering support and constant encouragement. How lucky I am to have all of you in my life.

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Lastly, I am including one of my favorite sayings, a quote by Mother Teresa. Although it shares little relevance with this project, I like to believe I live my life according to these words.

"People are often unreasonable, irrational, and self-centered. **Forgive them anyway**.
If you are kind, people may accuse you of selfish, ulterior motives. **Be kind anyway**.
If you are successful, you will win some unfaithful friends and some genuine enemies. **Succeed anyway**.
If you are honest and sincere people may deceive you. **Be honest and sincere anyway**.
What you spend years creating, others could destroy overnight. **Create anyway**.
If you find serenity and happiness, some may be jealous. **Be happy anyway**.
The good you do today, will often be forgotten. **Do good anyway**.
Give the best you have, and it will never be enough. **Give your best anyway**.
In the final analysis, it is between you and God. **It was never between you and them anyway**."

Table of Contents

Abstract……1

Executive Summary…….2

Project Inspiration……2

Author's Note……...3

Chapter 1……..4

Introduction……..4

Methods……..14

Results……32

Discussion……..34

Chapter 2……41

References……..53

Appendix A……63

Appendix B……....64

Appendix C……....65

Appendix D……66

Appendix E……68

Abstract

The public health community has remained focused on the direct effects and mental health implications of mass shootings, even as the frequency of these events rises in the United States. Although the immediate, deadly effects are apparent, it is crucial to identify the indirect effects these tragedies have on community members, particularly newborns. The purpose of this study was to assess changes in newborn birth weight in communities that have experienced mass shootings. Using birth weight data from the CDC's Division of Vital Statistics and mass shooting data from the Stanford Geospatial Center Database on Mass Shootings in America, a retrospective cohort study was conducted, with cases identified through exposure to a mass shooting. Covariates included but were not limited to: sex, birth order, gestation period, five-minute APGAR score, and maternal age, race, and educational status. Birth weight was affected by mass shootings, as three of four linear regression models showed a net decrease. This study offers insight into the unfortunate position that the United States is in right now regarding mass shootings and the indirect consequences of these tragedies, even as tension mounts within the political landscape and gun policy remains largely unchanged.

Executive Summary

This senior comprehensive project fulfills the requirements of the Biology department and the Global Health Studies program. The Biology senior comprehensive project requires students to have an experimental design, methods section, data collection plan, and resulting analysis and discussion sections. Datasets were collected from the CDC's Division of Vital Statistics and the Stanford Geospatial Center's Mass Shootings in America project. This epidemiological retrospective cohort study first identified the exposure group and then followed the group over time to determine the outcome (birth weight). To fulfill the requirements of the Global Health Studies major, interwoven throughout this research project are themes related to the department's four pillars:

1. Science, Health, and the Environment
2. Ethics and Social Philosophy
3. Policy, Poverty, and Economics
4. Cultures and Societies

Project Inspiration

This project was conceived during the summer of 2015 after hearing President Obama address the nation in the aftermath of the Charleston church shooting. To see the leader of our nation console Americans after another mass shooting was difficult to watch, yet inspiring. This project has also grown out of personal concern for gun safety in our country. I am astounded that our country is in its current situation, with seemingly endless accounts of gun violence permeating the media daily. It truly is an American phenomenon, as this project attempts to address. After spending a summer in India, I gained a greater respect for life and the peaceful practices that many Hindus showcase in their daily lives. Tragedies at Columbine, Virginia Tech,

and Sandy Hook have shown that horror can affect anyone at anytime unfortunately. The grief and sadness expressed by the friends and families of the victims have inspired me to pursue a research topic that could address unknown concerns of these mass shootings. When an event of unimaginable consequences occurs, there will most certainly be unintended repercussions. This senior comprehensive project will attempt to identify at least one of them.

Author's Note

While peer-reviewed literature was extensively researched in order to complete this project, due to the nature of the subject and its relationship within the media, included are sources of information that can be considered "gray literature". These sources include news media articles, documentary films, and other websites. The rise of mass shootings and use of social media has combined to produce a vast array of resources that are not necessarily academic or scientific in nature. Nonetheless, it is important that they are used when detailing effects of these tragedies.

Chapter One: A Retrospective Cohort Study

"The regularity of mass killings breeds familiarity. The rhythms of grief and outrage that accompany them become—for those not directly affected by tragedy—ritualised and then blend into the background noise. That normalisation makes it ever less likely that America's political system will groan into action to take steps to reduce their frequency or deadliness. Those who live in America, or visit it, might do best to regard them the way one regards air pollution in China: an endemic local health hazard which, for deep-rooted cultural, social, economic and political reasons, the country is incapable of addressing. This may, however, be a bit unfair. China seems to be making progress on pollution."

– from "The latest American mass killing", *The Economist*

Introduction

The Biological Pathway of Stress

Stress is an increasingly unfortunate component of life. At the biological level, the stress response is activated in order to maintain a state of homeostasis. Any changes to this state can trigger the stress response, which leads to physiological changes within the body. Although the human body has become adapted to handling stress over time, it still affects physiology, as well as emotional well-being. Activation of the stress response sets in motion a series of changes that were created in order to keep the individual alive (commonly referred to as the "fight or flight" response). The main component of the stress-response system is the hypothalamic-pituitary-adrenal axis (HPA). Composed of glands, this axis connects the brain and nervous system with the immune, reproductive, endocrine, and metabolic systems. The main function of the system is to regulate stress hormones (Schneiderman, Ironson, & Siegel, 2005; Everly& Lating, 2002). The process begins by the release of corticotropin-releasing factor (CRF) when the individual is exposed to a stressful event. CRF plays an important role in the autonomic nervous system and is associated with reproductive behavior and feeding. The CRF then binds to active sites in the pituitary gland, which then releases adrenocorticotropic hormone (ACTH) throughout the body. It is the ACTH that induces the adrenal cortex to create glucocorticoids, steroid hormones that are otherwise known as cortisol in humans. This chemical determines the physiological changes

that occur in the body in response to stress. Cortisol works within a negative feedback loop, serving as the regulator for HPA activity. At varying levels, it can induce or inhibit activity within the hypothalamus and the pituitary gland (Schneiderman, Ironson, & Siegel, 2005; Everly& Lating, 2002). There are many more neural and brain components that contribute to the HPA, but a basic understanding of the stress response is sufficient for the nature of the research project. It is important to remember that while beneficial to everyday life or certain situations in relative concentrations, too much accumulation of stress hormones, such as endorphins or cortisol, can have negative impacts on the tissues and glands. As with many biological systems, the HPA is partly determined by the genetic make-up of the individual. This can help to explain why some individuals react to the same stressor in different ways. Certain life experiences can also affect the HPA's function (Everly& Lating, 2002).

The stimulus of a stress response in the body is known as a stressor, which can be divided into two main categories: psychosocial stressors and biogenic stressors. For this research, only psychosocial stressors will be discussed, as biogenic stressors completely bypass the cognitive component of the stress response and directly act on the body. Such examples of biogenic stressors can be caffeine or nicotine. In contrast, environmental events are defined as psychosocial stressors, and they can be real, imagined, anticipated, or even recalled. These stressors differ from biogenic stressors because they cannot bypass the cognitive component of the stress response. The individual must register the event as a stressor for the response to begin. Even though stress can be induced by a number of stressors, the response system remains relatively the same independent of the stressor (McEwen & Tucker, 2011).

In particular, maternal stress is interesting to dissect because not only is the mother affected; the health of the newborn must also be considered. Throughout time, many cultures

have associated a mother's psychological status with the health of the newborn infant. The link between maternal stress and the newborn child has been studied for decades, with many studies highlighting the importance for mothers to maintain a healthy, psychological status during pregnancy. However, overall negative pregnancy outcomes related to maternal stress have not been significantly reduced over recent times (Agustines et al., 2000; Branum & Schoendorf, 2002; Mathews, Curtin, & MacDorman, 2000; Vohr et al., 2000). This may be due to the number of factors that can contribute to stress in pregnant woman, including age, education level, marital status, socioeconomic status, poor preparation, and mental health issues. The combination of these elements makes studying the effect of stress complicated and multifaceted, instead of solely focusing on physiological factors (Km et al., 1996).

The effects of stress on the fetus during pregnancy are of importance to study because of the lack of improvement in pregnancy outcomes, but also because of the high stress environments that the majority of the population is exposed to in today's society (Driskell & Salas, 2013). While most consider stress to be mentally and emotionally taxing, it has been shown that stress can physically alter the chemistry in the mother's body or influence her actions in a way that is detrimental to the fetus (Khashan et al., 2008). When a mother is stressed, her body releases catecholamines, which limit the flow of oxygen and nutrients to the fetus, a condition known as placental hypoperfusion. This reduction in nutrients can lead to either preterm delivery or growth impairment (Omer, 1986). Other pathways that send signals of stress to the fetus include the transplacental transport of maternal stress hormones and the release of CRF into the intrauterine environment (Mulder et al., 2002). A similar stress response in the body results in a higher amount of stress-related corticosteroids that increase the likelihood of the fetus or infant contracting an infectious disease (Omer, 1986). Additionally, there are an

increased number of CRF and cortisol receptors in the uterus and ovaries that affect sexual as well as reproductive function (Mulder et al., 2002). Furthermore, it has been shown that the fetus will respond to women who are more anxious than those that are not. Studies like this prove that the fetus recognizes signals that are related to the stress response (Van den Bergh, B R H et al., 1989). Stress can also result in spontaneous abortions or miscarriages, heart defects, preeclampsia, preterm delivery, and reduced birth weight (Mulder et al., 2002).

Biological factors and birth weight

Although stress can contribute to the birth weight of newborn infants, there are many biological factors that influence birth weight, regardless of the presence of stress. According to the World Health Organization (WHO), a baby born at a weight between 2,500 and 4,000 grams is considered to be of normal weight. Infants that are born under 2,500 grams are considered to be low birth weight, as epidemiological studies have shown that these low birth weight babies are twenty times more likely to die than babies of heavier weight (WHO & UNICEF, 2004). There is a debate as to if this cutoff is appropriate for classifying the newborns of different races, as mothers of different races have varying characteristics, such as average height and weight (Rooth, 1980).

When considering other biological factors, maternal age is generally a good indicator for birth weight. As women age, their bodies become less supportive of child growth and development. These mothers are at greater risk for having preexisting health conditions that could affect the pregnancy and are at greater risk for developing diabetes and hypertension. The babies of older mothers are also at greater risk for the development of malformations or genetic disorders during the pregnancy (Swamy et al., 2012). Women over the age of forty were found to be at increased odds for a pregnancy resulting in a stillbirth, pre-term delivery, long gestational

period, and a Caesarean delivery (Kenny et al., 2013). With increasing age, the odds of having a low birth weight baby also increase, as does having a preterm delivery. Also, there is a higher incidence of giving birth to underweight babies for extremely young mothers, aged seventeen or less, and also for older mothers, demonstrating a U-shaped relationship, with mothers between the ages of fifteen and forty being at lower risk for having low birth weight babies. (Aldous & Edmonson, 1993; Lee, Ferguson, Corpuz, & Gartner, 1988). Although these trends are seen in large cohorts and may not apply to each individual during their pregnancy experience, birth weight is not independent of maternal age.

Race should also be considered as a determinant for birth weight. Over recent years, Africa-American mothers have been at increased odds for giving birth to low birth weight and very low birth weight babies (Swamy et al., 2012; Catov et al., 2016). In a Northern California study with over 1,500 infants, babies that were identified as Hispanic, Asian, or Other had a lower mean birth weight, length, and smaller head circumference than babies identified as White (Madan, Holland, Humbert, & Benitz, 2002). Obesity before pregnancy and hypertension both disproportionally affect African-American women, would could be the reason for this group's predisposition for giving birth to low birth weight babies (Catov et al., 2016). Regardless of differences in disease rates between ethnic groups, the social differences displayed within racial groups are more than likely responsible for the difference in pregnancy outcomes (Collins & David, 2009).

Birth order, or parity, serves as one of the biggest determinants of birth weight. It has been shown to increase fetal growth during pregnancy, not the overall gestational length of the pregnancy. Increased fetal growth is directly related to weight gain in the fetus (MacLeod & Kiely, 1988). With increasing parity, mothers give birth to heavier babies. Yet, the physiology of

each pregnancy is different, which will have an effect on birth weight, so parity is not the only factor associated with increasing weight of newborns (Wilcox, Chang, & Johnson, 1996; Swamy et al., 2012). When a mother gives birth to more than one baby during a single pregnancy, the average weights of the newborns are generally lower than that of a singleton pregnancy. Also, giving birth more than once within two years has been found to contribute to lower birth weight babies (Metgud, Naik, Mallapur, & Szecsi, 2012).

One review of many epidemiological studies suggests that genetic factors have been found to account for 30-80% of birth weight variance. Even with a huge range, this estimate can help to explain the familial trends in birth weight. However, a wide variety of genes play a role in infant birth weight, such as the parental, placental, and fetal genes, and the true association between all three types is not yet known (Johnston, Clark, & Savage, 2002).

Social factors and birth weight

Biological factors play a key role in the weight outcome of infants, yet activities that mothers engage in while pregnant can have even larger impacts. The greatest factor that negatively influences birth weight is smoking. According to the Centers for Disease Control and Prevention's (CDC) Pediatric Nutrition Surveillance System, infants born to mothers who smoke cigarettes during pregnancy are forty times more likely to die shortly after birth than infants born to nonsmoking mothers. The percentages of low birth weight and full-term low birth weight are significantly higher for infants whose mothers smoke (CDC, 2010). For young mothers, socioeconomic status plays a crucial role in determining if they seek out prenatal care. For example, a highly-educated would be more likely to know when and how often to seek prenatal care; women with higher incomes would be able to afford more prenatal visits. Additionally, a

woman's occupation may determine the health insurance that she receives, influencing the level and quality of prenatal care (Hughes & Simpson, 1995).

Environmental stressors and birth weight

Those who reside in communities of high stress and low economic and social status experience worse health outcomes than those that live comfortably in other areas (Wallace, 2011). There are many theories as to how a community can influence the health of its denizens, such as structural and environmental stress models. The structural model refers to how the community is operated and managed; examples can range from low to high poverty, which can be the basis for the community's socioeconomic status. This status can, in turn, influence health. Another type of model is an environmental stress model, which deals with issues that are frequently seen in the headlines of media sources. Pollution, oil spills, exponential population growth, and other natural disasters and risks fall into this category (Wandersman & Nation, 1998). Even with these existing models, there is a difference of opinion in the literature as to how exactly a neighborhood or community can influence health. While some argue that it is the access to healthcare and facilities that contribute most to health disparities between communities, the most relevant aspect of community health that will be discussed is the presence of *social stressors* within an environment, which lead to negative stress for community members (Braun et al., 2015). It has been well documented that children who grow up in areas of high crime, arguably stressful environments, can experience mental health issues long after the occurrence (Boxer, Sloan-Power, Piza, & Schappell, 2014; Farrell & Bruce, 1997; Tzoumakis, Lussier, & Corrado, 2014).

Additionally, there is an assortment of studies that discuss the association between various social factors and their effect on birth weight (David & Collins, 1997; Khashan et al.,

2008; Wallace, 2011). One study in the Chicago area found that neighborhoods and their specific characteristics influenced the trends seen in low birth weight over the years. Wallace found that mass de-housing and the migration of minorities into New York City during the 1970's increased the incidence of infants of low birth weight. Also, Khashan et al. determined that mothers that had been exposed to severe life events, such as a cancer diagnosis or the death of a close relative, before conception or during pregnancy, are more likely to give birth to underweight babies than mothers lacking a severe life event in their past. These severe life events can refer to a personal tragedy or even a community experiencing high stress.

A particularly interesting viewpoint on community stress is the idea of communal bereavement. This term refers to "the widespread experience of distress among persons who never met the deceased" (Catalano & Hartig, 2001). A national study in Sweden measured the association between two significant country-level crises - the assassination of their Prime Minister in 1986 and the sinking of the ferry, *Estonia*, in 1994 - and very low birth weight. In the years following the two tragedies, the incidence of infants born at very low birth weight rose significantly, suggesting that bereavement of lives lost can be transferred within a large community (Catalano & Hartig, 2001). Similarly, the terrorist events of September 11th have been associated with low birth weight infants. There were increased odds of having a low birth weight infant among mothers on the Manhattan Island compared to mothers who were not living in Manhattan following the World Trade Center attacks (Eskenazi, Marks, Catalano, Bruckner, & Toniolo, 2007).

Stress, mass shootings, and health outcomes

Another example of an event that can lead to stress within a community is a mass shooting. The Federal Bureau of Investigation (FBI) does not strictly define a mass shooting, but

has defined a mass killing as “one with three or more fatalities in a report about active shooter…an individual actively engaged in killing or attempting to kill people in a confined and populated area…” (FBI, US Department of Justice, 2013). According to the Harvard School of Public Health, mass shootings, which typically include four or more people killed, have become far more frequent over the past thirty years (Cohen, Azrael, & Miller, 2014). Further, following the two-high profile mass shooting events in 2012 – the Aurora, Colorado movie theater shooting and the Sandy Hook massacre – news editors coined *mass shootings* as the prominent news story of the year (Associated Press, 2012). While mass shootings are not strictly an American phenomenon, one could argue that it is becoming epidemic in nature within the United States. From the years 2000 to 2014, the United States experienced 133 mass shooting events, whereas a combination of ten other advanced countries only experienced a total of twenty-three mass shootings combined during the same time period (Schildkraut & Elsass, 2016). For example, Canada only experienced three mass shooting events during the near fifteen-year study period. Currently the United States is third on a list of ranking mass shooting fatalities per 100,000 people as 0.15 deaths. These mass shootings have resulted in the deaths of 487 people and have injured 505 (Schildkraut & Elsass, 2016). Researchers say that the only reason the United States is not first on this list is due to the fact the Norway and Switzerland have much smaller populations and that the two countries both experienced high casualty mass shootings (Schildkraut & Elsass, 2016).

Although this type of event does occur in other nations around the world, the frequency of mass shootings in the United States is higher than those of other countries. According to the Mass Shooting Tracker database, which defines a mass shooting as an “event in which four or more people are injured, there were 294 mass shooting events over the course of the first 274

days in 2015 (shootingtracker.com, 2015). Although this source's victim criteria differ from the FBI's definition, the statistics highlight the continued occurrence of gun violence in the United States. Additionally, gun violence in America as a whole has accounted for more deaths than both foreign *and* domestic terrorism combined over the past decade. According to the CDC, 406,496 people died as a result of firearms between 2001 and 2013. In comparison, the total number of deaths over the same time period due to terrorism was 3,380 (CDC, 2015).

Whereas the direct health consequences of mass shootings have been reported and studied, the indirect health effects are more difficult to identify. Cherry found the prevalence of post-traumatic stress disorder (PTSD) in the parents of children exposed to a school shooting to be three percent. However, when identifying PTSD in the children either directly or indirectly affected by the attack, the percentage leapt to ninety-one percent (Cherry, 2015). PTSD was also used as an outcome for a study performed with the survivors of the Utøya Island massacre in Norway. Among the study participants, PTSD was associated with their general mental health problems; there was also significance in reporting of functional impairments and reduced life satisfaction (Dyb et al., 2013). Lastly, another post-shooting study showed that the Californian community of San Ysidro reported significant trauma symptoms and distress among community members following a massacre at a local McDonald's, with one in every three community members reporting mild to severe PTSD symptoms. These findings further contribute to the idea that a mass shooting impacts more than just the victims (Hough et al., 1990).

Study Design

Although it has been found that mass shootings can have indirect effects on individuals and communities, there is a lack of research on the indirect effects of mass shootings on pregnant women. The intention of this study was to determine if a specific community-level event with

disastrous consequences (a mass shooting) has an effect on the birth weight of infants. This study embodies the tenets of public health and epidemiology as it is centered on select populations and communities around the country. The pre-existing datasets that are being used for this research project are useful due to the amount of time saved and the amount of information they provide. It would have taken far longer to collect individual birth weight data for the years of interest (and it may have been nearly impossible as a student researcher working on a semester schedule). The number of variables used for this experiment was limited due to this schedule and to better pinpoint the effects. Also, the variables were a mixture of biological and social factors, as well as specialized shooting factors. Better yet, there are no associated costs with downloading the data. In this way, this research project is extremely cost-effective, a major consideration for all public health ventures today. Although this research is clearly a semi-topical analysis of publicly available data, it is the hope of the investigator that research on gun violence will receive more funding in the future to draw further conclusions.

Methods

Publicly available data were analyzed in a retrospective cohort study.

Metadata

Birth data was obtained and downloaded from the National Center for Health Statistics[1] (NCHS) Vital Statistics Natality Birth Database (through the CDC's Division of Vital Statistics) for the years 1968 to 2004 (henceforth *CDC data*). Each dataset was a census of all of the births that occurred in the United States for that particular year. For the years prior to 2005, identifying variables, such as demographic characteristics and geographic location, were included in the publically available dataset. However, the publicly available data from 2005 to 2014 did not

[1] *Disclaimer*: Any analyses, interpretations, or conclusions should be credited to the principal investigator, and not to NCHS, which is responsible only for the initial data.

include demographic identifiers. Since demographic information was crucial to the current research question, a more specific dataset was requested from the National Association for Public Health Statistics and Information Systems (NAPHSIS). The majority of the downloaded datasets contained 200 unique variables and recodes[2].

Mass shooting data was requested from the Stanford Geospatial Center Database on Mass Shootings in America[3] (henceforth *MSAD*) (Stanford, 2015). The database recorded the incidence of each mass shooting[4], beginning in 1968 and continuing through present day. Each mass shooting incident was recorded in the database with detailed information on the date and place of the shooting, number of guns used, number of victims, military experience of the shooter, etc. In total, there were thirty-seven variables for each shooting in the *MSAD*, in addition to the online sources that were used to verify the shooting.

Data cleaning, organization, and merging

A significant amount of time was spent merging the *CDC data* and the *MSAD*. The *CDC data* consisted of a census of all of the births, which varied over both geographic space and time. In contrast, the *MSAD* was comprised of incident reports, effectively serving as an account of a random allocation of mass shootings over space and time. Combining the two datasets proved to be challenging because the space and time of the births did not directly align with the space and time of the mass shooting. A successful merge matched the census births for a particular location with a mass shooting that occurred in the same location.

[2] A screenshot of the 2002 dataset is included within Appendix A.
[3] A screenshot of the MSAD is included within Appendix B.
[4] As defined by the Stanford researchers, a mass shooting event is any shooting that results in three or more victims, not including the shooter and unrelated to gang violence.

In order to determine an effect of mass shootings on the birth weight of newborns born within those counties[5], data collection began by downloading the CDC datasets in STATA format from the online resource. The request for data for years 2005 to 2015 was not fulfilled as of March 15, 2016, therefore eliminating these years from consideration in this study. The CDC datasets prior to 1982 were removed from analysis because the Federal Information Processing Standard (FIPS) code county-level identifier variable was not used[6].

Once collected and organized, specific variables from each of the datasets were chosen to be examined in particular relation to the research question: attendant at birth, birth year, birth month, birth county (FIPS code), birth weight, live birth order, sex of child, five-minute APGAR score[7], plurality[8], gestation, age of mother, race of mother, educational status of mother, marital status, total number of prenatal visits, maternal weight gain, and average number of cigarettes smoked per day. Next, all of the yearly datasets were reduced to the variables listed earlier and appended into one dataset. This created a census of all births in the U.S.A. over the study period.

Next, all of the counties that did not experience a mass shooting over the study period of 1982 to 2004 were dropped from the appended dataset. The birth records which occurred during years for which there was no mass shooting were also dropped. For example, if a shooting took place in County "X" in 1982, all of the births that took place in County "X" from 1983 to 2002 were dropped from the dataset. These steps were necessary in making the dataset manageable and feasible to work with through the technology available at Allegheny College. Furthermore,

[5] A list of the mass shootings counties is included within Appendix C.
[6] A FIPS code is a unique five-number code, different than a zip code, which distinguishes all of the counties in the United States.
[7] A measurement of the physical condition of a newborn. A newborn can score a 0, 1, or 2 within five categories: heart rate, respiratory effort, muscle tone, response to stimulation, and skin coloration, resulting in a score range of 0 – 10.
[8] Refers to the number of children born at one time during the same pregnancy.

birth weights change over time, and comparisons of births that are closer in time are less likely to be affected by time trends in birth weight and other health determinants.

The first step upon receiving the *MSAD* was to encode the dataset[9]. Although the county of incidence was reported, the corresponding FIPS code was not. The FIPS code was added to each individual mass shooting incident in the *MSAD*, making it geographically relatable to the *CDC data*. It was found that some counties have more than one associated FIPS code. Shootings from these regions were removed from the analysis. Removing these counties allowed for the most accurate measurement of whether and how a newborn was exposed to the shooting. The appended *CDC data* and the *MSAD* were then merged by county. A child was matched to the *MSAD* if the birth county FIPS code and the shooting county FIPS code were the same.

Following this merge, the next step was to generate the exposure group. This group was identified first based on exposure to a mass shooting at some point during pregnancy. This group was then followed to determine an outcome (birth weight). If the mass shooting event occurred after the date of birth, the child was considered *unexposed*. These newborns were the controls. If the mass shooting occurred anytime within nine months of the date of birth, the child was considered *exposed*. The exposure category was defined by a period of 280 days, which is the full-term gestation period for pregnancy. The exposure variable remained as a binary indicator.

Statistical Analyses

To assess the relationship between birth weight and mass shooting events, bivariate analysis was used. Linear regression models were constructed with birth weight as the dependent variable, *exposure* as the main independent variable of interest, and other independent variables grouped within four main categories. Performing this type of analysis demonstrated how much birth weight (the dependent variable) changed when the independent variables were altered. Put

[9] The *MSAD* data dictionary is included within Appendix D.

simply, the multiple linear regressions displayed how much the birth weight changed when the independent variable was increased by one unit. This change is known as the correlation coefficient. For this study, the correlation coefficient represented the change in grams, which was the unit for birth weight. For example, the units for maternal age are years. When one year is added to maternal age, the coefficient describes how much the birth weight changes. Graphically, the multiple linear regressions produce a best-fit line through the data points; the slope of that best fit line is also the correlation coefficient. Traditionally, these slopes are reported as integers, as shown below in Table 3.

There were four categories of models used for this experiment. For the *biological model*, controls were: sex of child, birth year, birth month, live birth order, five-minute APGAR score, plurality, gestation, maternal weight gain, age of mother, and race of mother. For the *social model*, controls were: educational status of mother, marital status, total number of prenatal visits, attendant at birth, birth county (FIPS code), and average number of cigarettes smoked per day. For the *shooting model*, controls were: number of guns, military experience of the shooter, possible motive, the shooter's relationship to the incident location, and the number of victims. The control variables for this method were also considered as effect modifiers, as they are not independent of the *exposure* variable. The fourth and final model included the controls from all of the other three models. All statistical analyses were performed using STATA 14/MP software[10] (StataCorp, 2015).

Table 1. Demographic Characteristics of CDC Birth Data Sets for years 1982-2002

	Mass Shooting

[10] The STATA Do-file used to organize, merge, and analyze data is included within Appendix E.

Birth Characteristics	Exposed *n*=442,005	Unexposed *n*=2,907,686
Sex of child		
Male	226,139 (51.2)	1,486,099 (51.1)
Female	215,866 (48.8)	1,421,587 (48.9)
Birth weight		
≤1,500 grams	6,229 (1.4)	43,798 (1.5)
1,500 – 2,500 grams	26,815 (6.1)	182,621 (6.3)
≥2,500 grams	408,961 (92.5)	2,681,267 (92.2)
Attendant at birth		
Doctor of Medicine or Osteopathy	427,864 (96.8)	2,805,294 (96.5)
Certified Nurse Midwife	11,321 (2.6)	78,190 (2.7)
Other	2,690 (0.6)	22,914 (0.8)
Unknown	130 (0)	1,288 (0)
Birth order		
Firstborn	181,736 (41.1)	1,167,877 (40.2)
Second born	138,778 (31.4)	904,774 (31.1)
Third born	70,094 (15.9)	479,313 (16.5)
Fourth born or greater	49,007 (11.1)	351,935 (12.1)
Unknown	2,390 (0.5)	3,787 (0.1)
Gestation period		
17 – 37 weeks	76,969 (17.4)	537,747 (18.5)
38 – 42 weeks	330,451 (74.8)	2,187,840 (75.2)
≥43 weeks	23,432 (5.3)	126,663 (4.4)
Unknown	11,153 (2.5)	55,436 (1.9)
Plurality		
Single	431,865 (97.7)	2,830,129 (97.3)
Twin	9,739 (2.2)	73,794 (2.5)
Triplet or higher	401 (0.1)	3,763 (0.2)
Maternal age		
17 years old or younger	165,326 (37.4)	21,844 (0.8)
18 – 40 years old	241,531 (54.6)	2,854,435 (98.1)
41 years or older	35,148 (8.0)	31,407 (1.1)
Maternal race		
White	313,903 (71.0)	2,050,567 (70.5)
African American	95,290 (21.6)	664,813 (22.9)
Asian	24,277 (5.5)	168,160 (5.8)
Other	8,535 (1.9)	24,146 (0.8)
Maternal education status		
High school diploma or lower	189,150 (42.8)	1,563,100 (53.8)
Some college or higher	120,851 (27.3)	1,069,453 (36.8)
Unknown	132,004 (29.9)	275,133 (9.4)
Marital status		
Married	299,622 (67.8)	1,912,336 (65.8)
Unmarried	142,281 (32.2)	994,972 (34.2)
Unknown	102 (0)	378 (0)
Number of prenatal visits		
None	10,514 (2.4)	56,407 (1.9)
1 – 20 visits	324,421 (73.4)	2,519,934 (86.7)
≥21 visits	4,167 (0.9)	33,480 (1.2)
Unknown	102,903 (23.3)	297,865 (10.2)

Table 1. (continued)

Five-minute Apgar score		

Score of 0 – 3	1,433 (0.3)	11,595 (0.4)
Score of 4 – 6	2,738 (0.6)	21,154 (0.7)
Score of 7 – 10	256,297 (58.0)	1,954,719 (67.2)
Unknown	181,537 (41.1)	920,218 (31.7)
Average number of cigarettes per day		
None	109,870 (24.9)	1,232,969 (42.4)
Have smoked	266,290 (60.2)	985,946 (33.9)
Unknown	65,845 (14.9)	688,771 (23.7)

Table 2. Characteristics of the Stanford Geospatial Center's Mass Shootings in America Database for years 1982-2002

Characteristics	**n**

Mass shooting incidents	61
Shooter sex	
Male	60
Female	1
Shooter age (m±SD)	33.00±5.02
Shooter race	
White	40
African-American	11
Asian	6
Other	4
History of mental illness	
Yes	36
No	22
Unknown	3
Past military experience	
Yes	11
No	50
Fate of shooter at scene	
Arrested	38
Deceased*	21
Escaped	2
*Cause of shooter's death	
Killed	4
Suicide	17
Victim fatalities (m±SD)	7.96±4.05
Victims injured (m±SD)	6.25±2.91
Number of guns used (m±SD)	1.77±0.77
Automatic guns (m±SD)	0.012±0.13
Semi-automatic guns (m±SD)	0.98±0.39
Handguns	1.60±0.68
Rifles	0.073±0.27
Shotguns	0.095±0.39
Place of shooting	
School/University	26
Entertainment/Retail venue	9
Government facility	13
Office	7
Other	6
Relationship to shooting location	
Place of schooling	22
Place of employment	23
Place of residency	8
Other	8
Possible motive	
Mental illness	11
Failure/Rejection	9
Expelled/Suspended/Terminated	13
Finances	6
Multiple motives	12
Other	9
Unknown	3

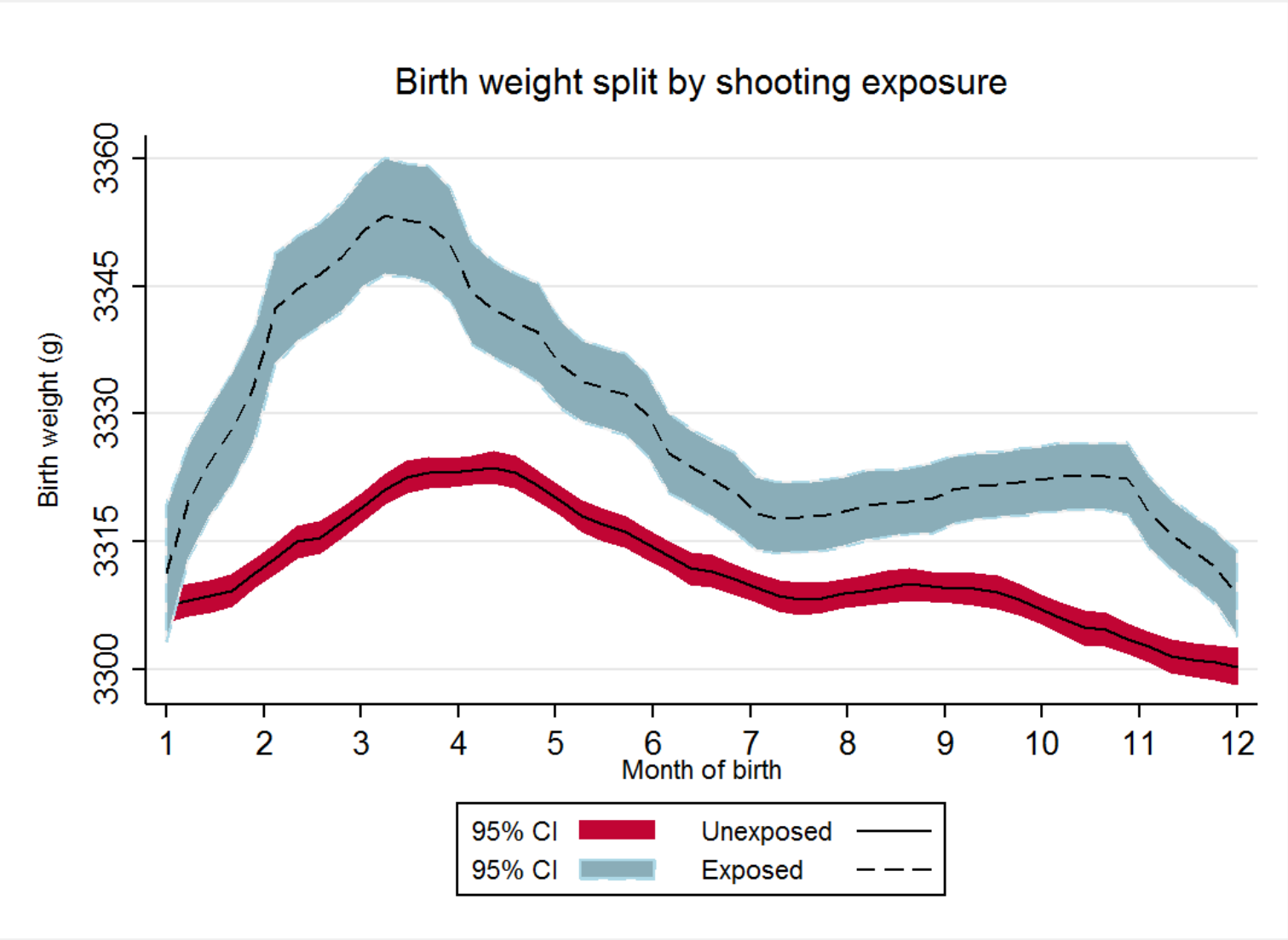


Figure 1. Local polynomial smooth plot of birth weight split by shooting exposure**.** Exposed babies experienced a mass shooting at some point during pregnancy, and unexposed babies did not experience a mass shooting before birth.

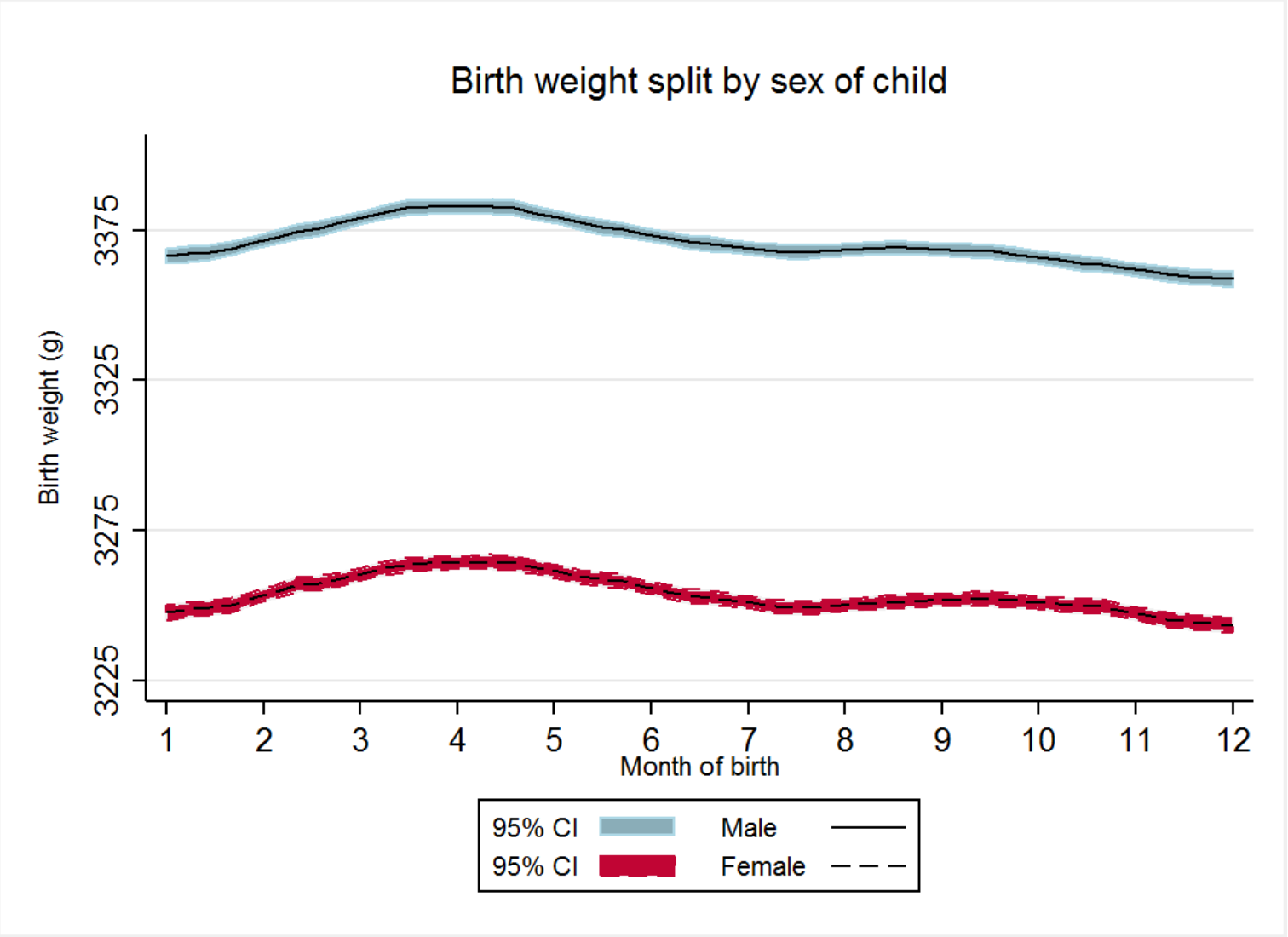


Figure 2. Local polynomial smooth plot of birth weight split by sex of child.

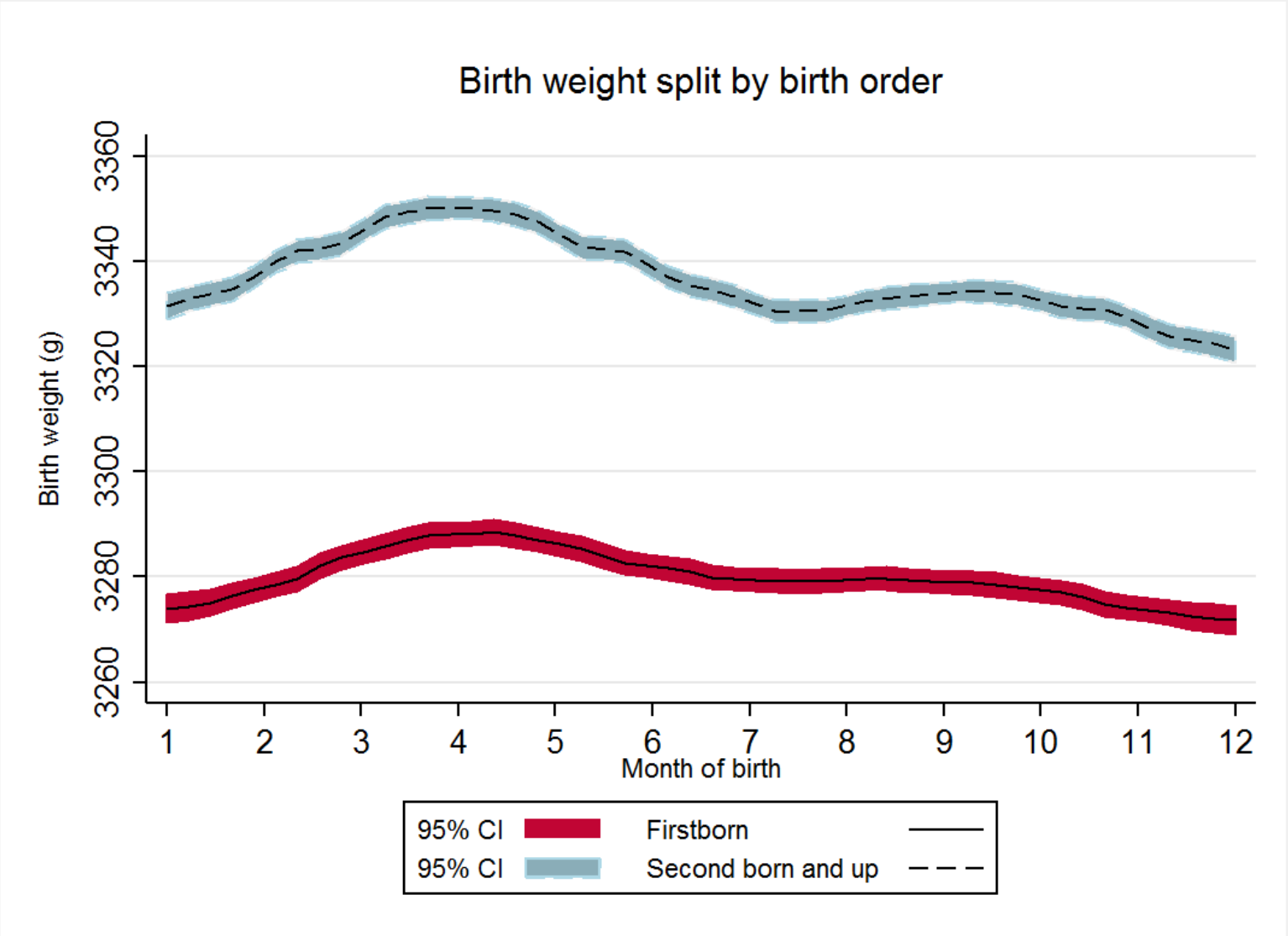


Figure 3. Local polynomial smooth plot of birth weight split by plurality. Plurality refers to birth order. The order of babies in this study is based on the order of live births by the mother and does not include failed pregnancies or those that did not produce a live child.

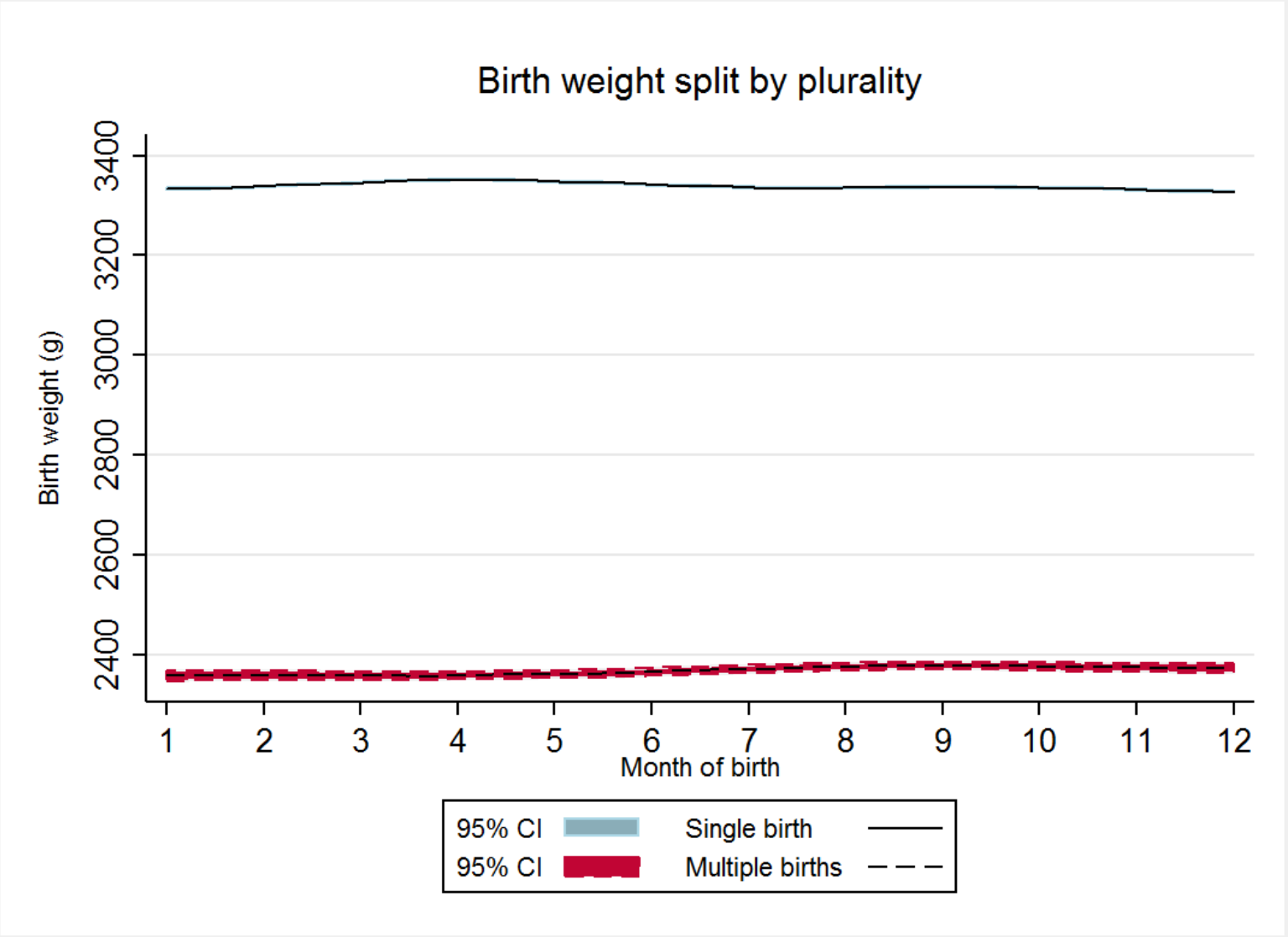


Figure 4. Local polynomial smooth plot of birth weight split by plurality. Plurality refers to the number of children conceived and born during the same pregnancy period. For example, multiple births can refer to twins, triplets, quadruplets, etc.

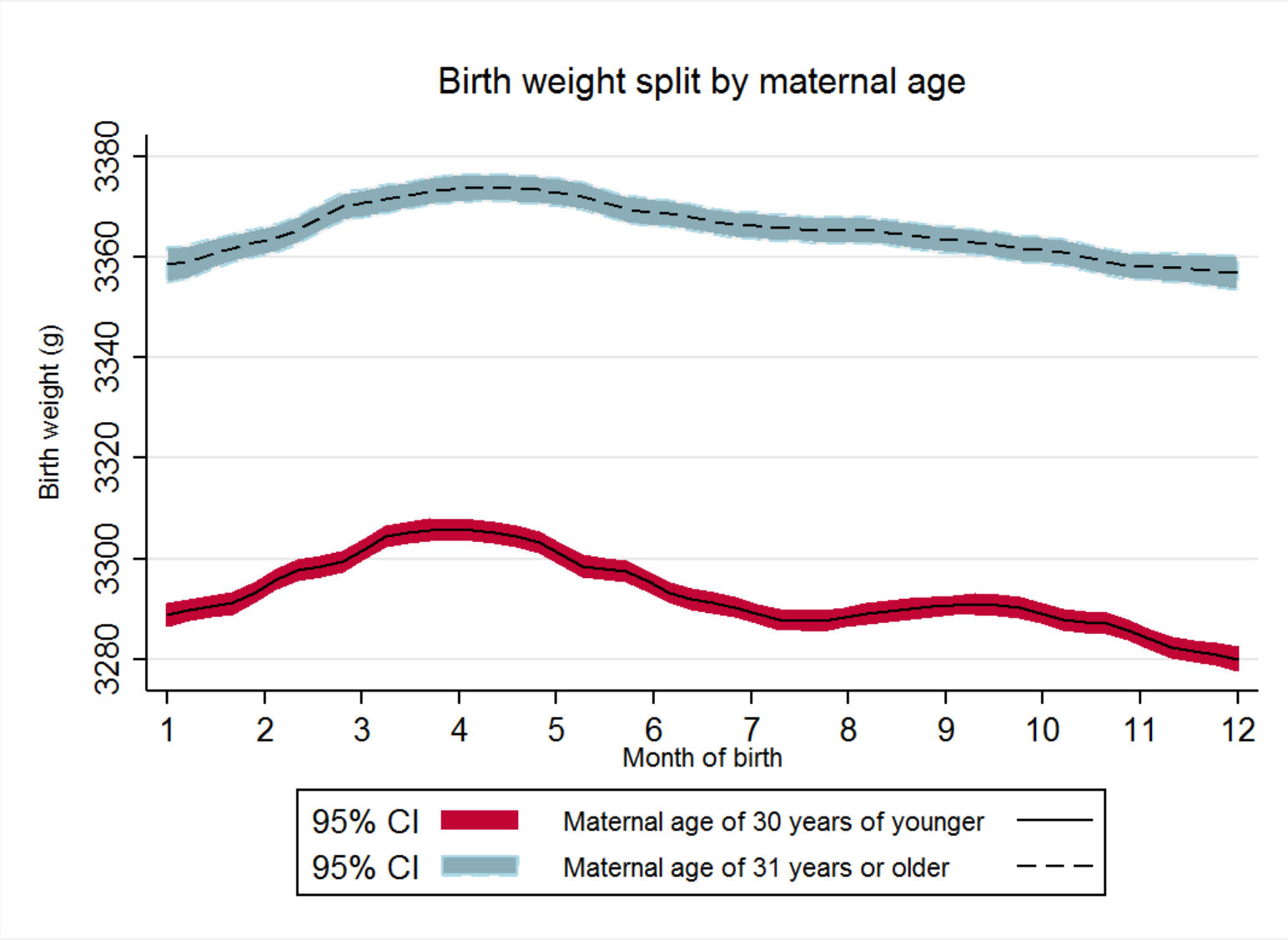


Figure 5. Local polynomial smooth plot of birth weight split by maternal age.

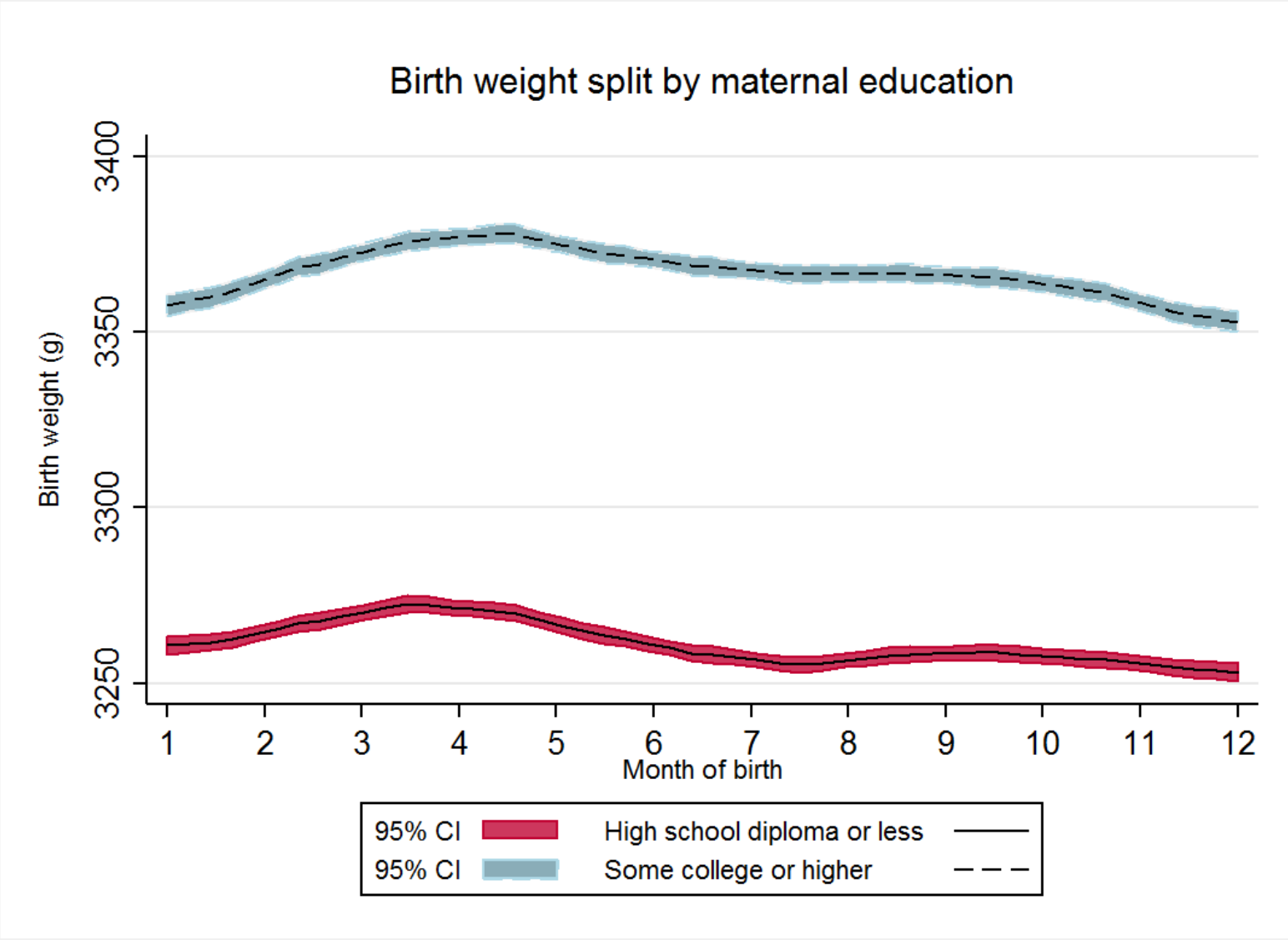


Figure 6. Local polynomial smooth plot of birth weight split by maternal education. High school diploma or less can include any educational status ranging from no schooling to twelve years of school. Mothers categorized as some college or higher include any education status from one year of college or higher.

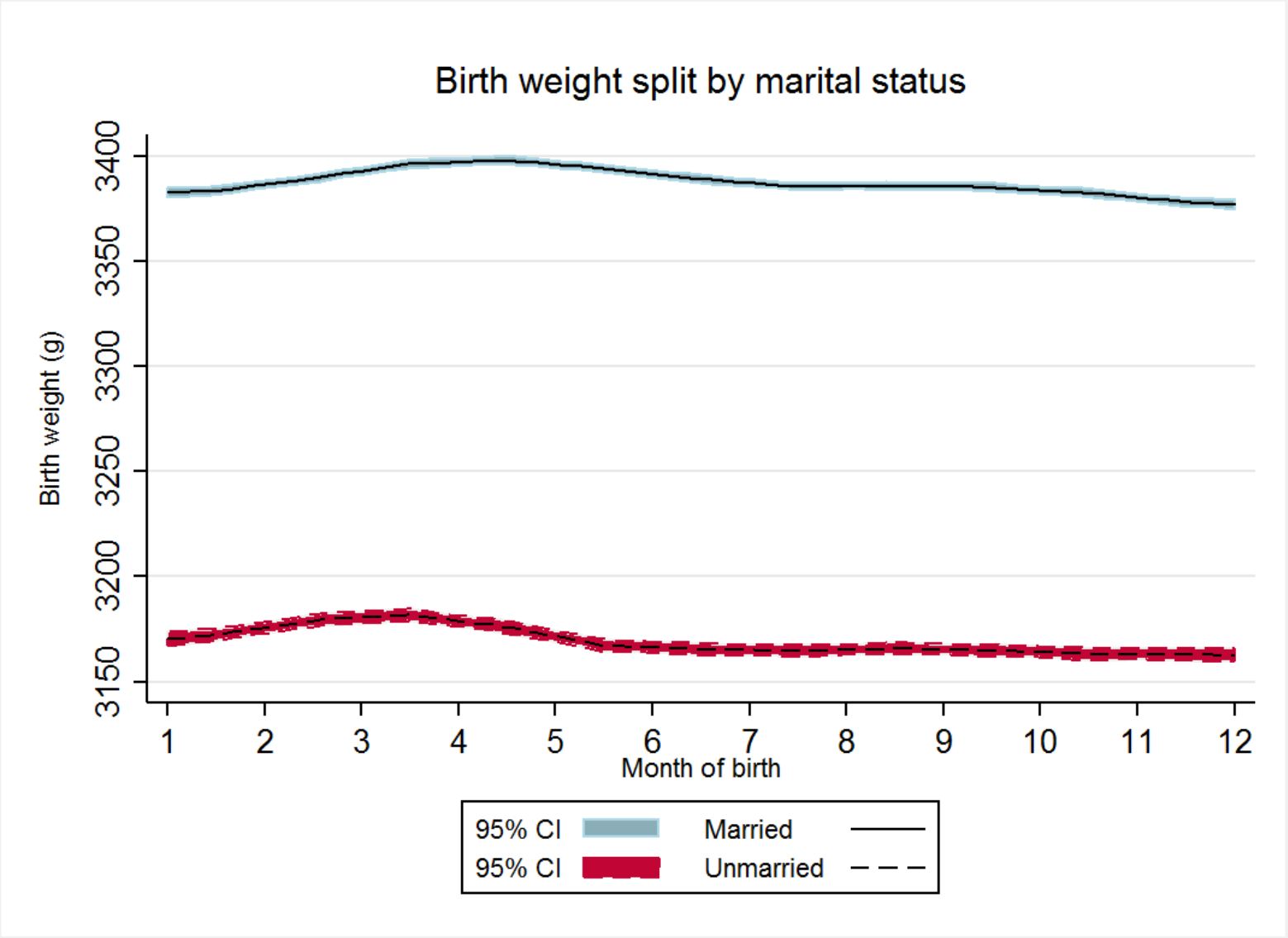


Figure 7. Local polynomial smooth plot of birth weight split by marital status.

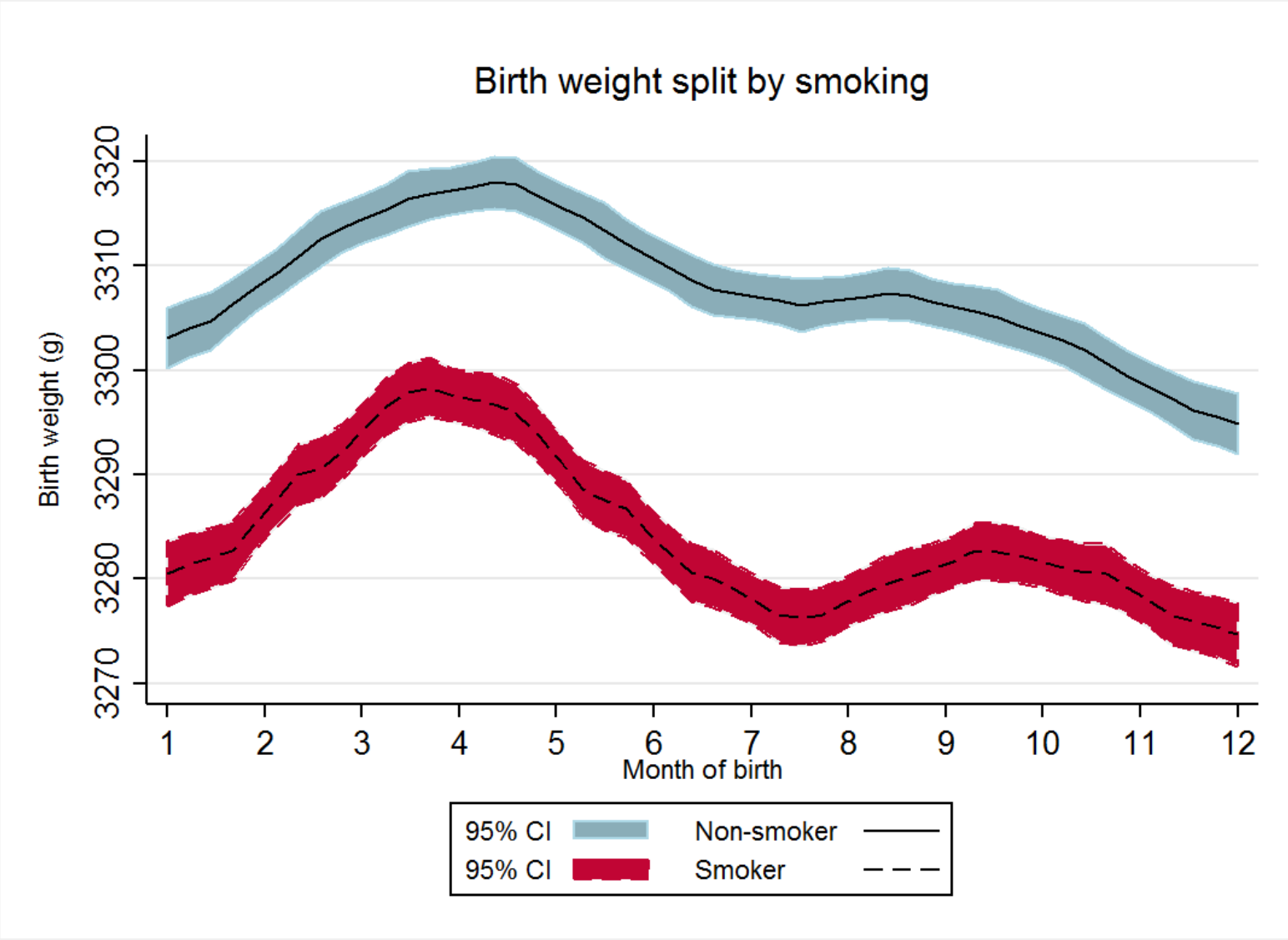


Figure 8. Local polynomial smooth plot of birth weight split by smoking. Non-smokers reported no cigarette use, and mothers who reported smoking behavior ranging from one cigarette a day or more.

Table 3. Multiple linear regression models with birth weight as the dependent variable

	Units/Type	(1) Biological Factors	(2) Social Factors	(3) Shooting Factors	(4) Combination
Exposure to shooting	Exposure (Binary)	5.937***	-5.470***	-29.845***	-163.973***
Sex of child	Sex (Binary)	-120.537***			-121.537***
Month of birth	Months (Categorical)	-1.649***			-1.079***
Year of birth	Years (Categorical)	-2.464***			-9.428***
Gestation	Weeks (Continuous)	-422.975***			-424.560***
Live birth order	Firstborn or not (Binary)	72.532***			80.894***
Age of mother	Years (Continuous)	4.805***			0.626***
Race of mother	Race (Binary)	-225.469***			-183.512***
Weight gain	Pounds (Binary)	-40.810***			-26.913***
Five-minute APGAR score	APGAR Score (Binary)	24.782***			-180.844***
Plurality	Births (Binary)	-798.772***			-784.513***
Marital status	Marriage Status (Binary)		-214.547***		85.073***
Education of mother	Years of schooling (Binary)		-26.935***		-36.029***
Average number of cigarettes per day	Cigarettes (Binary)		-36.372***		-91.929***
County of residence (FIPS)	FIPS County (Categorical)		0.002***		0.002***
Attendant at birth	Type of Attendant (Binary)		79.746***		58.097***

Table 3. (continued)

Number of prenatal visits	Prenatal visits (Binary)		-110.793***		-57.830***
Number of Guns	Guns (Continuous)			0.967 (0.329)	-25.155***
Exposed* Number of guns	N/A			15.274***	46.158***
Military experience of shooter	Military experience (Binary)			-83.163***	31.169***
Exposed*Military experience of shooter	N/A			23.039***	62.928***
Possible motive	Type of motive (Categorical)			3.684***	8.615***
Exposed*Possible motive	N/A			0.840*** (0.001)	6.760***
Shooter relationship to incident location	Shooter relationship (Categorical)			15.006***	3.865*** (0.001)
Exposed*Shooter relationship to incident location	N/A			-0.520 (0.729)	15.554***
Number of victims	Victims (Continuous)			2.664***	1.640***
Exposed*Number of victims				-0.527*** (0.007)	-0.222 (0.335)
Constant		8331.475***	3395.878***	3286.598***	22332.356***
Observations		3349691	2594595	3349691	2594595
R^2		0.192	0.043	0.006	0.211
F (variables, observations)		F (11, 3,349,679)	F (7, 2,594,587)	F (11, 3,349,679)	F (27, 2,594,567)
Prob > F		0.0000	0.0000	0.0000	0.0000

p-values in parentheses (all unreported *p*-values were 0.000)
* p<.10, ** p<.05, *** p<.01

Results

Figures 1 through 8 display the differences in birth weight when considering various factors. One birth weight trend observed throughout all of the figures is a rise in birth weight during spring months, such as March, April, and May. Though the birth weight axis is not consistent throughout all of the figures, the same pattern is seen. There also tends to be a decline in birth weight for late fall and winter months, such as October, November, and December. When birth weight was split by exposure to a mass shooting, the exposed group had a higher mean birth weight compared to the unexposed. The monthly flow of birth weight is consistent with both groups, but the 95% confidence intervals never cross over one another (Figure 1). Male babies are born heavier than female babies (Figure 2), and children that are not firstborn tend to weigh more than babies that are firstborn (Figure 3). When a pregnancy results in multiple births, the newborns individually weigh less than a single birth (Figure 4). Smoking, educational status, and marital status are factors of birth weight, with married, college-educated, non-smoking mothers giving birth to heavier babies (Figures 6, 7, & 8). Mothers older than thirty-one years of age also give birth to heavier babies than mothers who are thirty years old or younger (Figure 5).

The results of the multiple linear regression models all led to a decrease in birth weight for the exposure independent variable, except for the biological model, in which babies exposed to mass shootings had a positive coefficient of 5.937 grams compared to babies not exposed to the shootings. In comparison, the social model had a coefficient of -5.470; the shooting model had a coefficient of -29.845, and the combination of all three models had an exposure coefficient of -163.973 (Table 3). The sex of the child had a consistent coefficient throughout, ranging from -120.537 to -121.537. Gestation also remained fairly constant, with only a difference of 1.585 grams between the biological and combination models. Plurality was also steady throughout the

regression models. The regression results for marital status mirrored Figure 7, with married mothers giving birth to babies that were, on average, 214.547 grams heavier than babies born to unmarried mothers. Similarly, smoking decreased birth weight by 36.372 grams, complementing Figure 8. Mothers identified as White gave birth to heavier babies than mothers identified as non-White, and as the number of prenatal visits decreased, so did the birth weight in both the social and combination models. One of the largest differences resulted from the APGAR score. In the biological model, a decrease in APGAR score lead to babies being born 24.782 grams heavier than those that recorded no decrease in APGAR score. However, in the combination model, a decrease in APGAR score resulted in a reduction of 180.844 grams in newborns compared to babies with no change in APGAR score (Table 3).

Based on the shooting model, an increase in the number of guns and the number of victims both led to babies being born heavier than babies that did not see an increase in either category. If the shooter had military experience, the babies were 83.163 grams lighter than the babies that experienced a shooting with a non-military perpetrator. Analyzing the results of the exposed*number of guns variable suggests that these two variables reinforce one another, as does exposed*military experience of shooter. The positive sign within the table denotes reinforcement. The exposed*number of victims suggest the two variables do not reinforce each other, since the model resulted in a negative value (-0.527). Although Figure 1 shows exposure to a shooting resulting in heavier babies, the combination model suggests that babies exposed to a shooting weighed 163.973 grams less than those unexposed. Also, an increase in the number of guns, when controlling for all of the other independent variables, resulted in a 25.155 gram reduction in birth weight. Military experience in the combination model resulted in a 31.169

increase in birth weight, while the number of victims' coefficient still remained a small positive number at 1.640 (Table 3).

Discussion

Pregnancy affects mothers differently. With varying levels of hormones, a women's pregnancy experience is subjective. Stress is dependent on and regulated by both physiological and social factors. People can interpret events differently contingent to their upbringing or current situation (Mulder et al., 2002). This understanding is crucial for interpretation of the findings. The results of this study suggest that mass shootings do have an effect on birth weight; however, the results are not conclusive. There were independent variables that decreased or increased birth weight in one model, but acted in the opposite manner within a different model. Nonetheless, three out of the four models resulted in a decreased birth weight when specifically observing the main independent variable of exposure to a shooting. This is in line with a previous study that found an increase of negative health symptoms for both those directly and indirectly exposed to certain traumas, such as mass shootings (Ford, Adams, & Dailey, 2006).

When a mass shooting occurs, it not only affects the victims of the attack; the uninjured witnesses, first responders, bystanders, and community as a whole can be affected by such an event (Cherry, 2015). When attempting to determine the indirect effects of a mass shooting on an individual, one must take into consideration their incident exposure. There are multiple components that comprise an individual's incident exposure. For instance, the proximity to the attack itself is a primary factor (Grills-Taquechel, Littleton, & Axsom, 2011). There is evidence that those within close proximity to the shooting suffer from not only mental health disorders and increased levels of stress and anxiety (Cherry, 2015; Dyb et al., 2013; Hough et al., 1990). Eskenazi et al. hypothesized that women who were farther away from the September 11th

terrorist attack in New York City would be affected by less stress compared to mothers who lived in close proximity to Manhattan, suggesting that indirect effects would decrease with increasing distance from the disaster (2007). This also reveals that disasters that occur in smaller communities should have a greater impact on its citizens, since there is less distance that separates these citizens from the incident location. In contrast, direct exposure to the Oklahoma City bombing was found to be unrelated to mental health outcomes in the victims or bystanders (Tucker, Pfefferbaum, Nixon, & Dickson, 2000). The various findings reveal the complicated nature of stress-related research, as the connections of exposure-linked health outcomes are unclear.

Another element of incidence exposure is the individual's acquaintance with the deceased or victims of the shooting (Grills-Taquechel, Littleton, & Axsom, 2011). One can imagine a mother experiencing higher levels of stress if she were close to one of the victims or first responders to the shooting. However, it is difficult to determine how an individual would react to having a family member, friend, or coworker exposed to the shooting, since the relationship itself is comprised of various factors that are hard to quantify. Even the family and friends of the shooter could be psychologically and physically affected. Furthermore, this research project made the assumption that the mass shootings would definitively cause stress, even though this may not have been the case in reality. It is hard to imagine a community member not being emotionally affected by a mass shooting within their community, but it is possible that those people exist. Although it can be assumed that greater incidence exposure leads to increased negative aftereffects, this would not be the case for all individuals. Additionally, incident exposure is comprised of exposure inventories, which include an individual's sensory perceptions of the event like seeing or hearing the attack or sustaining an injury (Grills-

Taquechel, Littleton, & Axsom, 2011). These inventories are once again subjective for each individual.

Other studies that were cited as precursors to this study were based on events of a national scale. For instance, the terrorist attack of September 11, 2001, could be classified as a deadlier tragedy than a mass shooting. It is no one's place to judge the intensity of tragedy for these events, but it does play a role when discussing the outcomes within certain populations. There are two factors that could have played a role in the results of this study. One could be that mass shootings are not big enough in scale to induce physiological changes at the population level. Even with an increase in victims, the additional violence of the mass shooting may not be enough to cause stress in mothers. Another reason could be that the county-level demographic is too large of a region to study the indirect effects of mass shootings. As mentioned earlier, future research may be better suited focusing on the actual cities in which the shootings took place. The study population also may have to be limited, to either the survivors of the shootings, relatives of the survivors or victims of the shooting, co-workers, or other individuals that were somehow related to the shooting in some manner. With a more concise interconnected ring of people related to the shooting, one may be able to pinpoint a more precise picture of health outcomes.

Another explanation of the results revolves around the counties that were included within the study. Many of the FIPS counties were in urban areas, including Los Angeles, New Orleans, and Miami. One could argue that the mean socioeconomic status of the citizens was higher in these regions than in other areas of the country. Mothers of higher socioeconomic status would be able to afford more variety and quantity of food, as well as provide for additional prenatal care services. With an abundance of food, this could lead to the mothers eating more food during pregnancy, hence making the newborns weigh more at birth (Siega-Riz et al., 2009; Viswanathan

et al. 2008; Rode et al., 2007). Additionally, in high stressful environments, individuals have been found to eat more and not as healthily. Stress increases the secretion of glucocorticoids, which in turn, increases the motivation for food. Insulin production is also increased, leading to an increase in food intake. Since the mass shooting would likely induce stress throughout the community, mothers might be more likely to forego healthy diets for ones that favor their stressful environments (Dallman, 2010).

One particular challenge with stress research is that the majority of it is based on self-reporting after the event. It is also time-sensitive, as stress can decrease over time, as those affected can come to terms with the tragedy. Stress must mimic chronic conditions in order to influence birth weight significantly, which refers back to the quality of the relationship to the incident and the victims (Catalano & Hartig, 2001). Also, birth weight may not have been the greatest predictor of maternal stress during pregnancy. There are other biological measures influenced by stress that could be used to measure the indirect impact of mass shootings, although most of these are related to the child's development in the years following birth.

It is important to note that the majority of the *p*-values within the linear regression table were 0.000. Very low *p*-values are common in studies with large sample sizes. However, statistical significance does not directly relate to practical significance (Lin, Lucas, & Shmueli, 2013). For this study, analysis of *p*-values was difficult due to the fact that most were reported as 0.000. Also, the statistical analysis chosen for this study, although useful, created difficulty in producing binary values for variables such as motive, shooter relationship to incident locations, and FIPS county of birth. Even to appropriate them as categorical variables as they were in the study, it is near impossible to determine where within the variable the actual change in birth weight occurred. The only assumption that can be concluded is that there *was* a change in birth

weight when these variables were changed. This harkens further research into the subject matter. Also, many of the variables were transformed into binary variables, even though the individual categories may have yielded critical insight. For example, maternal race was designated as White and Non-White rather than having a categorical variable with over six categories. This was done to effectively monitor the change in birth weight from one race compared with many others. If the variable were left in its categorical state, there would be no way to determine which race is accountable for the change in birth weight.

Limitations

Although this study attempted to highlight the indirect effect of mass shootings on birth weight, there is much more research that can be conducted on this subject. One easy solution would be to gain access to data from 2005 to 2014. More than half of the shootings included within the Stanford database took place after 2005, eliminating half of the cases from the very beginning. Inclusion of these shootings could potentially result in more accurate results and allow for a more precise conclusion of the effect of mass shootings on birth weight. Also, researchers at Stanford University compiled the mass shooting database that was used for this study. The Stanford researchers decided on the definitions and criteria for a mass shooting and accumulated the data points from media sources. Therefore, the dataset may be missing select data points that were overlooked or reported incorrectly by the media. Additionally, the motive behind the shooting is speculative in nature for most cases, so more error should be assumed. Also, the birth weight data sets were collected consecutively as time passed; with over forty years of data collection, various variables and categorizations changed. While most were accounted for during analysis, there is a potential for error.

Use of STATA software was new for the primary researcher, and many hours were spent learning how to use the statistical program. If the datasets could have been downloaded and used with SASS software, the data analysis component of the project would have proceeded quicker than it actually did. Also, the statistical software that was needed for this project was difficult to come by. Since this study used massive datasets, the standard software package provided by Allegheny College was not adequate enough to run the analysis. Consequently, the analysis had to be carried out on a professor's personal desktop until a laptop was purchased with the correct software. In this way, the research was regulated by times that worked for both the primary researcher and the professor. Another limitation was the timeframe in which this project was restricted. Normally, a research study such as this is not constricted by semester schedules. Without the scheduling limitations, further analysis could have been performed of the dataset, and maybe the request for additional data would have been fulfilled. Under these time constraints, the number of independent variables was limited to those selected in the study. While limitations exist within this study, the potential for a better understanding between mass shootings and birth weight far outweighed these concerns.

Future directions

In order to more fully understand the impacts of stress on pregnant women, a longitudinal study should be used. Mothers would be able to report stressful events, both personal and communal, to the researcher, who would also monitor levels of stress hormone. This proposed study design would be more accurate in its findings than the correlational results of this study. Future studies should also consider a wider variety of independent variables. Birth defects could affect birth weight, as well as alcohol use by the mother during pregnancy. Another independent variable to consider is gestational diabetes, which is common in overweight mothers or mothers

who gain over forty pounds during pregnancy. Maternal diet and the birth weights of the mother's previous children are also important factors. Lastly, controlling for the population size of the county may reveal greater insight into the socioeconomic status of the region, such as the potential for food deserts or rural vs. urban areas.

The findings of this study indicate that mass shootings do influence birth weight in some manner, although additional research is needed to clarify the results. By continuing research on mass shootings and gun violence, the indirect effects of these tragedies can be identified and addressed through a public health approach.

Chapter 2: Framing Gun Violence as a Public Health Issue

"Time and time again, a public health approach to solving health threats is a proven, evidence-based approach to improving health and preventing injury… Health epidemics don't end unless we intervene taking the best science about what does and does not work and using it. The epidemic of intentional gun violence can be reversed with a science-based approach. It happened with Ebola, it worked for automobile crashes and it can absolutely reduce gun violence."

- Dr. Georges Benjamin, executive director of the American Public Health Association

Author's Note: Within this section, the terms *gun* and *firearm* are used interchangeably. However, it is important to note that while all guns are considered firearms, not all firearms are guns. For the purposes of this study, guns and firearms will be referred to synonymously.

Public health, according to the WHO, is the combination of both public and private measures taken to prevent disease, promote health, and increase the quality and span of life for populations (2016). The three main functions of public health include: assessing and monitoring community and population health; proposing policy to solve health problems; and providing affordable care and services (WHO, 2016). The issues that public health addresses are those that fit these functions. Public health issues usually affect a large number of people within a population and negatively influence the lives of those faced with this problem. With this foundation, public health officials have called on gun violence to be labeled as a public health issue. As an issue that has affected hundreds of thousands this year alone, gun violence fits the criteria of a public health issue (CDC, 2015). The public health community is grounded on the belief that science can stop an epidemic. Through epidemiological research, fieldwork, and the proposition of policy, public health officials work to understand the nature of diseases among populations and how they affect communities. Even with outbreak situations, the implementation of public health practices has been effective in curbing the spread of infections and non-communicable diseases. Other successful public health endeavors have included vaccinations, food and water safety, workplace safety, family planning, and labeling tobacco as dangerous to one's health (WHO, 2016).

Many public health officials are comparing gun violence to automobile safety and how the public health community paved the way in reducing crashes and making the nation's roadways safer. For example, the CDC released a report stating that six times as many people drove a car in 2000 than in 1925, yet the mortality rate associated with automobile crashes and injured was reduced by over ninety percent. This reduction was made possible through the public health framework that was implemented. By focusing on technological adaptations, policy implementation, and behavior modifications, cars and roadways were made safer, stricter laws were passed in regards to driving, and the public was educated on the dangers of driving. Although not immediately successful, the public health community managed over time to create positive, life-saving measures (Troisi & Williams, Houston Chronicle 2016). It is in this way that current public health officials are demanding gun violence be explored.

When an issue is deemed a public health issue, there are a variety of implications that arise. Economics play a key role in public health issues. According to the Harvard T.H. Chan School of Public Health, only around three percent of the country's gross domestic product is dedicated to public health expenditures (2012). This is in stark contrast to the increasing rise in healthcare expenditures over recent years. As a result, when an issue is deemed a public health issue, the nature of the solution usually begins with the economics and the funding source. Since 1996, a federal ban has prevented the CDC and the National Institutes of Health (NIH) from conducting research on gun violence, which has one of the highest death tolls in comparison to other diseases that the federal government approves funding to research. Daniel Webster, the director of the Johns Hopkins Center for Gun Policy and Research, said of the ban,

> It just affects the basic things we care about in public health – the mortality, the life expectancy, morbidity, mental health. It affects all of those things in pretty profound ways. If we had a disease that was killing as many people as our guns

> in our country, we would devote a lot more resources to make sure we had the best data, the best research to know what is most affected (Dennis, 2015).

Lawmakers claim that research on the subject could be used to lobby for an anti-gun agenda. With the National Rifle Association (NRA) serving as a huge player among conservatives, any attempt to repeal the ban has failed to pass, even after the frequency of mass shootings has risen. The most recent federal budget that was passed in December 2015 still included the federal ban, even after the House Gun Violence Prevention Task Force, led by Representative Elizabeth Esty (D-Connecticut), offered an amendment to the budget (Etsy, 2015). If gun violence were to be deemed a serious public health issue, this ban would have to be struck down in order for the federal government to begin research on the matter. Interestingly enough, the sponsor of the Dickey Amendment, which ended funding for gun violence research at the CDC is now in favor of funding gun violence research (De Blasio, 2016).

Linked with economics, especially at the federal level, public health issues are also political in nature, as one of the main functions of the field is to propose policy changes. It has been suggested that some of the shooters would not have passed the background check to purchase a firearm on their own. For example, Adam Lanza, the shooter responsible for the Sandy Hook Elementary School shooting, stole the weapons he used from his gun-enthusiastic mother (Llanos, 2012). However, an analysis of the deadliest shootings in 2015 found that most of the gunmen obtained their weapons legally (Chalabi, 2015). And just because the shooters theoretically would not have passed their background checks does not prove they would have never obtained a gun. Firearms can be purchased by other individuals and end up in the possession of someone else under a variety of circumstances, such as robbery in the Lanza case.

In fact, both of the Columbine shooters had other individuals purchase guns, as well as purchased guns from unlicensed sellers themselves (Moore, 2012).

Partly solidifying gun violence as a political issue, on January 4, 2016, the White House revealed the new executive action plan intended to reduce gun violence and make communities safer. The major component to this executive action plan is to increase the background check process, no matter the manner of purchase. This means that it does not matter where an individual decides to purchase a gun; he or she will still have to complete a federal background check in accordance with the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF). Whereas before an individual could purchase a firearm over the Internet or at a private gun show and not have to complete a background, this is no longer legal. No matter the location or type of transaction, any proprietor who chooses to sell a firearm must first obtain a license to do so, as well as complete a background check on the purchaser of the firearm. Congress launched the National Instant Criminal Background Check System (NICS) in November of 1998 in order to prevent certain individuals from obtaining a gun, and these executive action measures will increase the effectiveness of this system (FBI, 2010). This requirement also applies to organizations or companies that may decide to purchase firearms or other types of weapons. Sellers that refuse to follow these new guidelines will be subject to harsher penalties that include prison time and monetary fines.

Additionally, the FBI is making significant changes to its processes relating to background checks. Hundreds of supplementary personnel are being hired to examine background checks, which in theory will decrease the time it takes to notify the seller of the firearm purchaser’s legality in the transaction. This is a necessary change, as the NICS receives over 60,000 new applications per day. This change will also help to close the loophole in the

FBI's system, wherein a firearms dealer could complete the purchase of the sale to anyone if the background check was not returned in three days. With more staff members processing applications, they should be returned within the three-day period. In order to make communities safer, the ATF is hiring more staff members that will enforce the present and future gun laws. These taskforce members will be responsible for monitoring in-person and online sales and the shipment of any firearms to and from the seller (Office of the Press Secretary, 2016).

Interestingly, mental health services are also included within this executive action plan. A sum of over $500 million dollars is proposed to increase the care associated with mental health. No longer will there be loopholes in the reporting of an individual with mental health issues, as states will soon be required to report all instances. Under the Affordable Care Act, individuals have the right to mental health and substance abuse facilities, and more than $100 million has been granted to community health centers to expand their behavior-related services (Office of the Press Secretary, 2016). It is with these measures that the executive action plan will be implemented to sidestep Congress. The plan also aligns gun violence within public health, as it proposes new policy that hopes to enhance the lives of the United States population.

Another consideration of framing gun violence as a public health issue is the ethical disputes that begin to surface. Since the government is preventing federal research on gun violence, the private sector and independent researchers have the responsibility to delve into this subject and produce quality research and data (Kellermann & Rivara, 2013). Until the ban is lifted, the government entities that would usually respond to this epidemic are at a standstill. With gun violence serving as a major killer of Americans, regardless of mass shootings,

something must be done to curb the increasing trend these events have been on over recent years (Boylan, 2003). Studies on the direct and indirect effects of gun violence are crucial to understanding the nature of the crimes and the first steps in preventing them. It should be a priority of the nation's leaders to address the epidemic that is taking thousands for lives each year. It appears that the country has turned a blind eye to gun violence, labeling it as an unsolvable, innate characteristic of the American people. Much like research funding has made roads safer and drownings less common, so too could research and funding reduce gun violence (Kellermann & Rivara, 2013).

Even with mass shooting survivors, like Gabby Giffords campaigning for gun control or other politicians calling for an end to the federal ban on gun research, there has been a lack of action and policy change regarding gun policy. There can be no change through inaction, a realization that led to the development of this project. Regardless of the empirical results of this study, it is of utmost importance to attempt to understand the behaviors of not only those that carry out these mass shootings and gun violence, but also the behaviors of those that respond or have the power to respond. To examine the ethical implications of the American government in terms of the response to increased gun violence is another research question in and of itself, yet imperative to the current research question. It is also the driving force behind the need for more research. The scientific community should produce results that force policy makers to act (Frattaroli & Teret, 2006). Research, therefore, should inform action, an idea that could resonate within the current environment surround gun violence in America. The ideal relationship would have policy at the receiving end of knowledge, no matter if the knowledge comes from public or private sources. This means including more than lawmakers within the conversation; physicians and researchers should be included as well (Frattaroli, Webster, & Wintemute, 2013).

Framing gun violence as a public health issue is also intertwined with cultural repercussions. According to the 2nd Amendment of the United States Constitution, every American citizen has the right to keep and bear arms. While not unique to America – other countries such as Mexico, Haiti, and Guatemala have constitutional provisions regarding the possession of firearms – the majority of countries do not have articles relating to firearms embedded in founding documents. However, just because a country has a firearm provision within its constitution does not equate to gun ownership. Mexico only has fifteen guns per one hundred citizens, in comparison to the United States having over ninety guns per one hundred citizens (Ajdacic-Gross et al., 2006). This showcases the difference between a right to bear a firearm, and the actual procurement of a firearm within the countries constituents.

Guns are tied to culture in America. The United States is home to more guns and ammunition than any other country in the world (Moore, 2012). Even looking past the constitutional right, guns are involved in hunting, recreational activities, as well as self-defense of citizens. The term "gun culture" was first used to describe America's affection for guns in 1970 (Hofstadter, 1970). This "gun culture" would have to be challenged if the world of public health began to counteract gun violence. If gun control were considered a public health issue, the main goal would not be to violate the 2nd Amendment. Instead, guns would be subjected to stricter regulation and safety standards, much like automobiles were during the fight to reduce automobile crashes and injuries.

One of the most important aspects of public health issues is the cooperation of the individuals upon which the intervention is focused. Behavioral change is a top priority within most public health initiatives. As mentioned with the automobile safety revolution, it was up to the drivers to make behavioral changes, such as wearing seatbelts and abiding by speed limits

and new road rules (Troisi & Williams, Houston Chronicle 2016). Behavioral change can come as a result of education, such as sex education or car safety education for teenagers. Education does not always mean that behavior changes are implemented, as seen with lack of condom use within educated teenagers (Furstenberg, Moore, & Peterson, 1985). The public health community would also have to be wary of the associated costs for the individual to take part in the change. For example, if guns were to be ordered to undergo inspections and modifications, the owners may not be willing to pay for this, even if it were signed into law. Therefore, either the public health community would have to cover the costs of these changes or provide some benefit to gun owners in order for them to comply with the proposed solutions.

However, a public health framework is not the sole framework in which to frame gun violence. Some view gun violence as a law enforcement issue. Since mass shootings are technically crimes, just on a larger scale, one argument is that additional monitoring and police activity are required in order to prevent these types of attacks. With armed police officers at a majority of public venues, the proposed solution believes that the shooter will be stopped either before he or she decides to act or within moments after carrying out an attack (Police Executive Research Forum, 2015). There have been calls for citizens to be trained and armed with weapons in order to fight off future perpetrators (Parker & McCarthy, 2015). At the federal level, the FBI and its Critical Incident Response Group are in charge of the National Center for the Analysis of Violent Crime (NCAVC). It is the mission of this organization to prevent mass crimes, such as mass shootings from happening. This is made possible in part by the national and international monitoring put in place in the aftermath of the September 11th attacks. The NCAVC attempts to be proactive, which can be challenging given the randomness of mass shootings and the presence of a single shooter (Junod, 2014). The comparison between

crime and increasing law enforcement is not unheard of, yet mass shootings are complex in nature and require an interdisciplinary approach, according to public health officials.

Similarly, these frameworks and various combinations of them have been used in other countries around the world in response to mass shootings. Many of the policies that are discussed were implemented soon after a massacre or a mass shooting that resulted in a high number of individuals killed. For example, after the deadly Port Arthur massacre in 1996 that left thirty-five people dead, Australian Prime Minister John Howard announced new measures that completely transformed the country's gun policy. Under the National Firearms Programme Implementation Act 1996, the government developed a gun buyback program a that saw more than 650,000 guns bought back by the government and removed from circulation among the general public. Weapons deemed as unnecessary for the average citizen, such as semiautomatic shotguns and rifles, were banned for public use. In the years following the policy changes and the gun buy-back program, researchers also point out that the average citizen's chance of dying from a gun-related injury was halved, and the rate of suicide dropped by eighty percent (Leigh & Neill, 2010). These policy changes together with an overwhelming majority of Australian citizens that supported gun control measures, these measures changed gun culture and its resulting violence throughout Australia.

Another country that has implemented new, successful gun policy is the United Kingdom. Parliament passed the Firearms (Amendment) Act of 1988, which made registration mandatory for any citizen that wanted to own a shotgun. Semi-automatic weapons were also banned under the new law (Firearms, 1988). After a school shooting in the mid 1990's, it was made illegal to own a private handgun with the United Kingdom. Following suit, pistols were banned in 1997, and firearm and ammunition amnesties (similar to buy-back programs)

removed several thousand of weapons off of the streets. Though there have still been mass shootings in the United Kingdom since the time these laws went into effect, gun violence as a whole has decreased. Furthermore, individuals must be cleared by the local police department, as well as examined by a physician, to attain a firearm. This is similar to the law in Finland, where a firearm license applicant must be cleared by law enforcement and a doctor and also prove that he or she has been an active member of a gun club for at least one year prior to buying a gun. Furthermore, by increasing the permit age by two years, from eighteen to twenty, the number of permit applications has dropped significantly by thousands every year since 2007 (McKirdy & Armstrong).

These countries have been able to take these measures for multiple reasons. One, the United Kingdom and Australia do not have a right to bear arms within their constitutions, which eliminates the possibility of violating citizens' rights. Another major difference is that certain weapons identified in the buyback programs were outlawed in these countries, whereas in the United States, that is not necessarily the case (i.e. handguns). The United States also has a fascination with "gun culture", which has resulted in mass quantities of weapons being produced, sold, and stockpiled within the country (Moore, 2012). The sheer number of weapons within the United States makes buyback programs unsuccessful from the start. According to a report by National Public Radio (NPR), gun buyback programs were instituted in the United States in the 1960's, yet have lacked traction in getting weapons off the streets (2013). Many redeemers of gun buyback programs turn in old guns that are mainly used for hunting. Indeed, the gun buyback programs in the United States have collected firearms, just not those used for homicides, or even suicides (Braga & Wintemute, 2013; Kuhn et al. 2002). There has also been evidence that claims gun buyback programs do not work, which forces

communities to question whether or not these types of programs are effective in the first place (Braga & Wintemute, 2013). Though international models exist for gun control, they are clearly not as effective within the United States, whether due to differences in law, implementation of the programs, or attraction with weapons.

Conclusion

Although gun violence has garnered attention through news headlines and the media, framing gun violence as a public health issue would bring additional attention from the scientific community and policy makers. Through research, data can be collected that could raise even more awareness to the issue, potentially leading politicians to a reversal on the funding ban. Work on gun violence could theoretically begin at anytime, as there are pre-existing datasets (much like the ones used for this study), which serve as abundant and informative resources. Use of this data is beneficial to researchers because it is free of charge and easily accessible (Grady, Cummings, & Hulley, 2013). Though the definition of mass shootings may vary from source to source, the databases exist and are waiting to be analyzed. Also, it does not require human subjects to proceed with the study. It would not be possible to design a study about gun violence due to the inherent risks to the participants. Similarly, if a researcher were to follow a certain population over time and record the instances of violence that occurred, it would take years of follow-up and data collection to draw any sort of conclusion. Therefore, use of preexisting databases solves the issue of time as well as eliminates the need for active participation in the study.

Existing datasets are also useful due to the variance in interpretation. For instance, this research project was originally conceived after hearing reports in the media of repeated mass shootings. Upon accessing the data, an epidemiologist, food economist, and a historian were all

influential in study design, data analysis, and the interpretation of the results. It can be argued that by using preexisting databases, it is easier to collaborate with researchers in other fields. Or, it is easier for many different types of researchers to be working on the same subject at the same time. Often, data is not shared until after a study is published; through the proposed method, the data is already publically available (Safran et al., 2007). This is an advantage, as a range of disciplines can analyze the data. Though this project serves as both an epidemiological retrospective cohort study and a public health approach to gun violence, it is not the only way that the data can be analyzed. The nature of gun violence and mass shootings are too complicated to be solved through one discipline or even the combination of two. It will certainly require a collaborative, interdisciplinary approach to solve the gun violence epidemic in America. A solution may be found within a pubic health framework that relies on data collection and analysis and the distribution of knowledge to influence policy.

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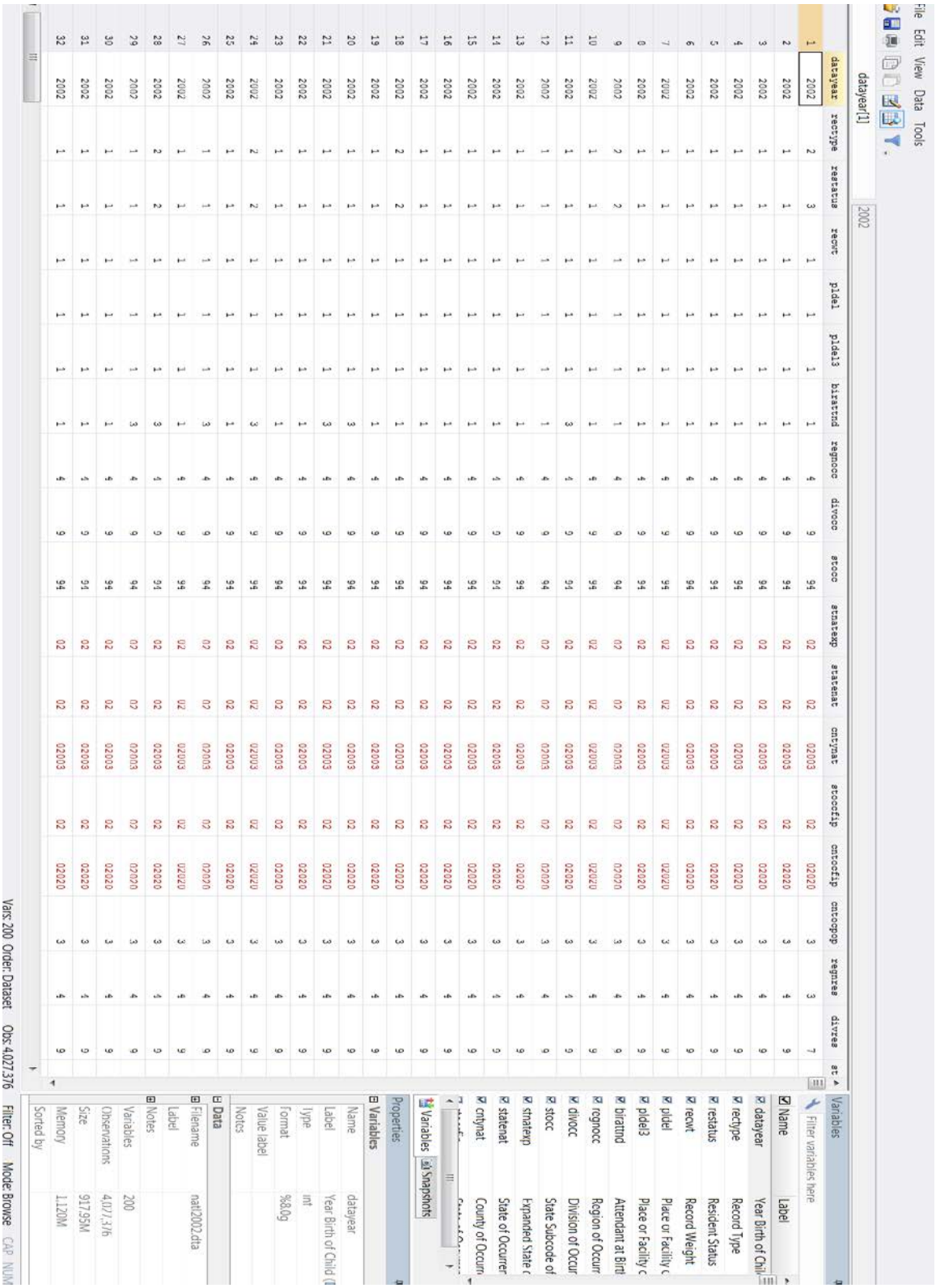
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APPENDIX A

Screenshot of 2002 *CDC data*



APPENDIX B

Screenshot of *MSAD*

CaseID	Title	Location	City	State	Number of Victim Fatalities	Total Number of Fatalities	Number of Victims Injured	Total Number of Victims	Description	Date	Day of Week	Date - Detailed	Shooter Name	Shooter Age(s)
1	University of Texas at Austin	Austin, Texas	Austin	Texas	16	17	32	48	On August 1, 1966, a 25-year-old engineering student at the University of Texas in Austin killed sixteen people and wounded thirty-two others in and around the Tower of the University of Texas. Prior to commencing the mass shootings at the University, the student and former U.S.	8/1/66	Monday	Monday, August 01, 1966	Charles S. Whitman	25
2	Rose-Mar College of Beauty	Mesa, Arizona	Mesa	Arizona	5	5	1	6	On November 12, 1966, an 18-year-old high school student entered the Rose-Mar College of Beauty in Mesa, Arizona, ordering his victims to lay on the ground in a circle. The gunmen shot and killed four women and a child and injured another woman and an infant. He considered a few sites, like his school, where he thought of	11/12/66	Saturday	Saturday, November 12, 1966	Robert Benjamin Smith	18
151	St. Aloysius Church	Spokane, Washington	Spokane	Washington	1	2	4	5	On November 11, 1971, a former MIT student entered St. Aloysius Roman Catholic Church on the Gonzaga University campus. The shooter killed the caretaker and wounded four more people before he was killed by police.	11/11/71	Thursday	Thursday, November 11, 1971	Larry J. Harmon	21
3	New Orleans Police Shootings	New Orleans, Louisiana	New Orleans	Louisiana	9	10	13	22	On New Year's Eve in 1972, a 23-year-old ex-Navy dental technician went to the central lockup New Orleans Police Department and shot four policeman that day. Seven days later on January 7, 1973, the shooter shot a grocer and entered the Downtown Howard Johnson Hotel where he shot seventeen	12/31/72	Sunday	Sunday, December 31, 1972	Mark James Robert Essex	23
4	Clara Barton Elementary School	Chicago, Illinois	Chicago	Illinois	1	1	3	4	people before killed him at the top of the On January 17, 1974, a 14-year-old student entered Clara Barton Elementary School in Chicago, Illinois and killed the principal and wounded three others before he was seized by a teacher when both his guns jammed. Apparently, the student was angry at the fact that he had been expelled from the school and transferred to a social	1/17/74	Thursday	Thursday, January 17, 1974	Steven Guy	14

APPENDIX C

Mass Shooting Locations

Las Vegas, Nevada
Miami, Florida
Seattle, Washington
Johnston, South Carolina
Los Angeles, California
Dallas, Texas
San Ysidro, California
Goddard, Kansas
Atlanta, Georgia
Brooklyn, New York
Edmond, Oklahoma
Lewistown, Montana
Palm Bay, Florida
Pinellas Park, Florida
Sunnyvale, California
Winnetka, Illinois
Chicago, Illinois
Greenwood, South Carolina
New Orleans, Louisiana
Stockton, California
Escondido, California
Louisville, Kentucky
Jacksonville, Florida
Phoenix, Arizona
Ridgewood, New Jersey
Killeen, Texas
Iowa City, Iowa
Royal Oak, Michigan
Olivehurst, California
Watkins Glen, New York
Great Barrington, Massachusetts
Dearborn, Michigan
Dana Point, California
San Francisco, California
Ogden, Utah
Fayetteville, North Carolina
Sheridan, Wyoming
Garden City, New York
Chelsea, Michigan
Union, Kentucky
Fairchild Air Force Base, Washington
Wickliffe, Ohio
Brookline, Massachusetts
Chapel Hill, North Carolina
Montclair, New Jersey
Lynnville, Tennessee
Moses Lake, Washington
Fort Lauderdale, Florida
San Diego, California
Bethel, Alaska
Aiken, South Carolina
Pearl, Mississippi
West Paducah, Kentucky
Orange, California
Milwaukee, Wisconsin
Newington, Connecticut
Jonesboro, Arkansas
Edinboro, Pennsylvania
Springfield, Oregon
Riverside, California
Conyers, Georgia
Atlanta, Georgia
Honolulu, Hawaii
Tampa, Florida
Melrose Park, Illinois
Santee, San Diego, California
Grundy, Virginia
Tucson, Arizona

APPENDIX D

Data Dictionary
Stanford Geospatial Center Mass Shootings in America Database

Variable: Location
Code: (based on time zone)
Eastern=1; Central=2; Mountain=3; Pacific=4

Variable: Day of Week
Code: Monday=1; Tuesday=2; Wednesday=3; Thursday=4; Friday=5; Saturday=6; Sunday=7

Variable: Shooter Sex
Code: Male=1; Female=2

Variable: Shooter Race
Code: White American or European American=1; Black American or African American=2; Asian American=3; Native American or Alaska Native=4; Some other race=5; Unknown=6

Variable: Type of Gun - General
Code: Handgun=1; Rifle=2; Shotgun=3; Multiple guns=4; Unknown=5

Variable: Fate of Shooter at the scene
Code: Arrested=1; Deceased=2; Escaped=3

Variable: Shooter's Cause of Death
Code: Killed=1; Suicide=2; Not applicable=3

Variable: School Related
Code: Yes=1; No=2

Variable: Place Type
Code: Primary school=1; Secondary school=2; College/University/Adult education=3; Place of worship=4; Restaurant/Café=5; Entertainment venue=6; Retail/Wholesale/Services facility=7; Government facility=8; Company/Factory/Office=9; Residential home/Neighborhood=10; Military facility=11; Street/Highway=12; Park/Wildness=13; Medical/Care=14; Public transportation=15

Variable: Relationship to Incident Location
Code: Place of schooling=1; Place of business/employment=2; Place of residency=3; Place of recreation=4; Local government=5; None=6; Unknown=7

Variable: Targeted Victim/s - General
Code: General public=1; Students/Classmates/Teacher=2; Colleague/Workmate/Business acquaintance=3; Government=4; Racial/Religious group=5; Family=6; Romantic partner=7; Social=8

Variable: Possible motive
Code: Mental illness=1; Political/Religious ideals=2; Race=3; Rejection=4; Terminated/Denied/Reprimanded=5; Social dispute=6; Financial dispute=7; Financial difficulties=8; Expulsion/Suspension=9; Failure=10; Harassment=11; Legal dispute=12; Domestic dispute=13; Multiple motives=14; Unknown=15; Drug use=16

Variable: History of Mental Illness - General
Code: Yes=1; No=2

Variable: Military Experience
Code: Yes=1; Unknown=2

APPENDIX E

```
*This is the Do-file for my senior project. It']s goal is to have all of the code needed for data analysis without making permanent changes to the original datasets. The goal of this project is to determine if mass shootings have an effect on birth weight

Garrett Devenney

clear

* Selection of key variables for the study.
* Age of mother
* Date of birth
* Birth order
* Sex of baby
* Birth Attendant
* Geographic region/county
* Race/ethnicity
* Smoking
* Education level of mother
* Birthweight
* Gestation length
* APGAR

*no wt_gain before 1989 (done)
*no marital_stat or apgar_5 before 1978 (done)
*no plural 1970 (done)
*no prenat_visit before 1972 (done)

/*use natl1968, clear
rename birmon birth_month
rename datayear birth_year
rename cntyres birth_county
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
rename dmeduc mat_educ
rename dgestat gestat
rename dplural plural
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race mat_educ gestat plural
save natl1968_new
clear

use natl1969, clear
rename birmon birth_month
rename datayear birth_year
rename cntyres birth_county
```

```
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
rename dmeduc mat_educ
rename dgestat gestat
rename dplural plural
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
mat_educ gestat plural
save natl1969_new
clear

use natl1970, clear
rename birmon birth_month
rename datayear birth_year
rename cntyres birth_county
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
rename dmeduc mat_educ
rename dgestat gestat
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
mat_educ gestat
save natl1970_new
clear

use natl1971, clear
rename birmon birth_month
rename datayear birth_year
rename cntyres birth_county
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
rename dmeduc mat_educ
rename dgestat gestat
rename dplural plural
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
mat_educ gestat plural
save natl1972_new
clear

use natl1973, clear
rename birmon birth_month
```

```
rename datayear birth_year
rename cntyres birth_county
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
rename dmeduc mat_educ
rename dgestat gestat
rename dplural plural
rename nprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
mat_educ gestat plural prenat_visit
save natl1973_new
clear

use natl1974, clear
rename birmon birth_month
rename datayear birth_year
rename cntyres birth_county
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
rename dmeduc mat_educ
rename dgestat gestat
rename dplural plural
rename nprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
mat_educ gestat plural prenat_visit
save natl1974_new
clear

use natl1975, clear
rename birmon birth_month
rename datayear birth_year
rename cntyres birth_county
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
rename dmeduc mat_educ
rename dgestat gestat
rename dplural plural
rename nprevis prenat_visit
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keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
mat_educ gestat plural prenat_visit
save natl1975_new
clear

use natl1976, clear
rename birmon birth_month
rename datayear birth_year
rename cntyres birth_county
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
rename dmeduc mat_educ
rename dgestat gestat
rename dplural plural
rename nprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
mat_educ gestat plural prenat_visit
save natl1976_new
clear

use natl1977, clear
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rename datayear birth_year
rename cntyres birth_county
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rename dmage mat_age
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rename dmeduc mat_educ
rename dgestat gestat
rename dplural plural
rename nprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
mat_educ gestat plural prenat_visit
save natl1977_new
clear

use natl1978, clear
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rename datayear birth_year
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rename dmeduc mat_educ
rename dmar marital_stat
rename dgestat gestat
rename fmaps apgar_5
rename dplural plural
rename nprevis prenat_visit
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mat_educ marital_stat gestat apgar_5 plural prenat_visit
save natl1978_new
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use natl1979, clear
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rename fmaps apgar_5
rename dplural plural
rename nprevis prenat_visit
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mat_educ marital_stat gestat apgar_5 plural prenat_visit
save natl1979_new
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use natl1980, clear
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mat_educ marital_stat gestat apgar_5 plural prenat_visit
save natl1980_new
clear

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rename birmon birth_month
rename datayear birth_year
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rename fmaps apgar_5
rename dplural plural
rename nprevis prenat_visit
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clear */

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rename mrace mat_race
rename dmeduc mat_educ
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rename nprevis prenat_visit
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mat_educ marital_stat gestat apgar_5 plural prenat_visit
save natl1982_new
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mat_educ marital_stat gestat apgar_5 plural prenat_visit
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rename nprevis prenat_visit
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mat_educ marital_stat gestat apgar_5 plural prenat_visit
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use natl1985, clear
rename birmon birth_month
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mat_educ marital_stat gestat apgar_5 plural prenat_visit
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use natl1986, clear
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rename nprevis prenat_visit
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mat_educ marital_stat gestat apgar_5 plural prenat_visit
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clear

use natl1987, clear
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rename datayear birth_year
rename cntyrfip birth_county
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rename dmeduc mat_educ
rename dmar marital_stat
rename dgestat gestat
rename fmaps apgar_5
rename dplural plural
rename nprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
mat_educ marital_stat gestat apgar_5 plural prenat_visit
save natl1987_new
clear

use natl1988, clear
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rename cntyrfip birth_county
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rename dplural plural
rename nprevis prenat_visit
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mat_educ marital_stat gestat apgar_5 plural prenat_visit
save natl1988_new
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rename cntyrfip birth_county
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rename dgestat gestat
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rename cigar smoking
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rename nprevis prenat_visit
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wt_gain mat_educ marital_stat gestat apgar_5 smoking plural prenat_visit
save natl1989_new
clear

use natl1990, clear
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rename cntyrfip birth_county
rename csex sex
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rename dmage mat_age
rename mrace mat_race
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rename nprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
wt_gain mat_educ marital_stat gestat apgar_5 smoking plural prenat_visit
save natl1990_new
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use natl1991, clear
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rename cntyrfip birth_county
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rename dmeduc mat_educ
rename dmar marital_stat
rename dgestat gestat
rename fmaps apgar_5
rename cigar smoking
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rename nprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
wt_gain mat_educ marital_stat gestat apgar_5 smoking plural prenat_visit
save natl1991_new
clear

use natl1992, clear
rename birmon birth_month
rename datayear birth_year
rename cntyrfip birth_county
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
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rename dmeduc mat_educ
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rename dgestat gestat
rename fmaps apgar_5
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rename nprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
wt_gain mat_educ marital_stat gestat apgar_5 smoking plural prenat_visit
save natl1992_new
clear

use natl1993, clear
rename birmon birth_month
rename datayear birth_year
rename cntyrfip birth_county
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
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rename dmeduc mat_educ
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rename nprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
wt_gain mat_educ marital_stat gestat apgar_5 smoking plural prenat_visit
save natl1993_new
clear

use natl1994, clear
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rename datayear birth_year
rename cntyrfip birth_county
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
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rename dmeduc mat_educ
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rename nprevis prenat_visit
```

```
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
wt_gain mat_educ marital_stat gestat apgar_5 smoking plural prenat_visit
save natl1994_new
clear

use natl1995, clear
rename birmon birth_month
rename datayear birth_year
rename cntyrfip birth_county
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
rename wtgain wt_gain
rename dmeduc mat_educ
rename dmar marital_stat
rename dgestat gestat
rename fmaps apgar_5
rename cigar smoking
rename dplural plural
rename nprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
wt_gain mat_educ marital_stat gestat apgar_5 smoking plural prenat_visit
save natl1995_new
clear

use natl1996, clear
rename birmon birth_month
rename datayear birth_year
rename cntyrfip birth_county
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
rename wtgain wt_gain
rename dmeduc mat_educ
rename dmar marital_stat
rename dgestat gestat
rename fmaps apgar_5
rename cigar smoking
rename dplural plural
rename nprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
wt_gain mat_educ marital_stat gestat apgar_5 smoking plural prenat_visit
save natl1996_new
clear
```

```
use natl1997, clear
rename birmon birth_month
rename datayear birth_year
rename cntyrfip birth_county
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
rename wtgain wt_gain
rename dmeduc mat_educ
rename dmar marital_stat
rename dgestat gestat
rename fmaps apgar_5
rename cigar smoking
rename dplural plural
rename nprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
wt_gain mat_educ marital_stat gestat apgar_5 smoking plural prenat_visit
save natl1997_new
clear

use natl1998, clear
rename birmon birth_month
rename datayear birth_year
rename cntyrfip birth_county
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
rename wtgain wt_gain
rename dmeduc mat_educ
rename dmar marital_stat
rename dgestat gestat
rename fmaps apgar_5
rename cigar smoking
rename dplural plural
rename nprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
wt_gain mat_educ marital_stat gestat apgar_5 smoking plural prenat_visit
save natl1998_new
clear

use natl1999, clear
rename birmon birth_month
rename datayear birth_year
rename cntyrfip birth_county
rename csex sex
```

```
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
rename wtgain wt_gain
rename dmeduc mat_educ
rename dmar marital_stat
rename dgestat gestat
rename fmaps apgar_5
rename cigar smoking
rename dplural plural
rename nprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
wt_gain mat_educ marital_stat gestat apgar_5 smoking plural prenat_visit
save natl1999_new
clear

use natl2000, clear
rename birmon birth_month
rename datayear birth_year
rename cntyrfip birth_county
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
rename wtgain wt_gain
rename dmeduc mat_educ
rename dmar marital_stat
rename dgestat gestat
rename fmaps apgar_5
rename cigar smoking
rename dplural plural
rename nprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
wt_gain mat_educ marital_stat gestat apgar_5 smoking plural prenat_visit
save natl2000_new
clear

use natl2001, clear
rename birmon birth_month
rename datayear birth_year
rename cntyrfip birth_county
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
```

```
rename wtgain wt_gain
rename dmeduc mat_educ
rename dmar marital_stat
rename dgestat gestat
rename fmaps apgar_5
rename cigar smoking
rename dplural plural
rename nprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
wt_gain mat_educ marital_stat gestat apgar_5 smoking plural prenat_visit
save natl2001_new
clear

use natl2002, clear
rename birmon birth_month
rename datayear birth_year
rename cntyrfip birth_county
rename csex sex
rename dbirwt birthwt
rename dlivord birth_ord
rename birattnd birth_attend
rename dmage mat_age
rename mrace mat_race
rename wtgain wt_gain
rename dmeduc mat_educ
rename dmar marital_stat
rename dgestat gestat
rename fmaps apgar_5
rename cigar smoking
rename dplural plural
rename nprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
wt_gain mat_educ marital_stat gestat apgar_5 smoking plural prenat_visit
save natl2002_new
clear

use natl2003, clear
rename dob_mm birth_month
rename dob_yy birth_year
rename mrcntyfips birth_county
rename sex sex
rename dbwt birthwt
rename lbo birth_ord
rename attend birth_attend
rename umagerpt mat_age
rename mrace mat_race
rename wtgain wt_gain
rename f_med mat_educ
rename mar marital_stat
rename combgest gestat
rename apgar5 apgar_5
```

```
rename cigs smoking
rename dplural plural
rename uprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
wt_gain mat_educ marital_stat gestat apgar_5 smoking plural prenat_visit
save natl2003_new
clear

use natl2004, clear
rename dob_mm birth_month
rename dob_yy birth_year
rename mrcntyfips birth_county
rename sex sex
rename dbwt birthwt
rename lbo birth_ord
rename attend birth_attend
rename mager mat_age
rename mrace mat_race
rename wtgain wt_gain
rename f_med mat_educ
rename mar marital_stat
rename combgest gestat
rename apgar5 apgar_5
rename cigs smoking
rename dplural plural
rename uprevis prenat_visit
keep birth_month birth_year birth_county sex birthwt birth_ord birth_attend mat_age mat_race
wt_gain mat_educ marital_stat gestat apgar_5 smoking plural prenat_visit
save natl2004_new
clear

/*use natl1968_new.dta
describe
append using natl1969_new
append using natl1970_new
append using natl1971_new
append using natl1972_new
append using natl1973_new
append using natl1974_new
append using natl1975_new
append using natl1976_new
append using natl1977_new
append using natl1978_new
append using natl1979_new
append using natl1980_new
append using natl1981_new*/

clear
use natl1982_new
append using natl1983_new
append using natl1984_new
```

```
append using natl1985_new
append using natl1986_new
append using natl1987_new
append using natl1988_new
append using natl1989_new
append using natl1990_new
append using natl1991_new
append using natl1992_new
append using natl1993_new
append using natl1994_new
append using natl1995_new
append using natl1996_new
append using natl1997_new
append using natl1998_new
append using natl1999_new
append using natl2000_new
append using natl2001_new
append using natl2002_new
save CDC_1982-2002_FINAL, replace

/*Some years are represented with just single numbers. This was changed to be
consistent with the other subsequent data years */
use CDC_1982-2002_FINAL
replace birth_year=1982 if birth_year==2
replace birth_year=1983 if birth_year==3
replace birth_year=1984 if birth_year==4
replace birth_year=1985 if birth_year==5
replace birth_year=1986 if birth_year==6
replace birth_year=1987 if birth_year==7
replace birth_year=1988 if birth_year==8
save CDC_1982-2002_FINAL, replace

/*For all the counties that had shootings and begin with a "0" in the FIPS code
also change equivalently in the shooting dataset. */
clear
use CDC_1982-2002_FINAL
destring birth_county, replace
replace birth_county=96037 if birth_county==6037
replace birth_county=96073 if birth_county==6073
replace birth_county=96085 if birth_county==6085
replace birth_county=96077 if birth_county==6077
replace birth_county=94013 if birth_county==4013
replace birth_county=96115 if birth_county==6115
replace birth_county=96059 if birth_county==6059
replace birth_county=96075 if birth_county==6075
replace birth_county=92050 if birth_county==2050
replace birth_county=99003 if birth_county==9003
replace birth_county=95031 if birth_county==5031
replace birth_county=96065 if birth_county==6065
replace birth_county=94019 if birth_county==4019
save CDC_1982-2002_FINAL, replace
```

```
*This step will generate a new variable to indicate a "shooting county" or not;
*one thing to remember is to get rid of the places with more than one county listed,
*because including those places wouldn't allow for the most accurate measurement of
*whether and how a baby was exposed to a shooting.

generate shooting_county=0
replace shooting_county=1 if birth_county==32003
replace shooting_county=1 if birth_county==12086
replace shooting_county=1 if birth_county==53033
replace shooting_county=1 if birth_county==45037
replace shooting_county=1 if birth_county==96037
replace shooting_county=1 if birth_county==48113
replace shooting_county=1 if birth_county==96073
replace shooting_county=1 if birth_county==20173
replace shooting_county=1 if birth_county==13121
replace shooting_county=1 if birth_county==36047
replace shooting_county=1 if birth_county==40109
replace shooting_county=1 if birth_county==30027
replace shooting_county=1 if birth_county==12009
replace shooting_county=1 if birth_county==12103
replace shooting_county=1 if birth_county==96085
replace shooting_county=1 if birth_county==17031
*replace shooting_county=1 if birth_county==17031
replace shooting_county=1 if birth_county==45047
replace shooting_county=1 if birth_county==22071
replace shooting_county=1 if birth_county==96077
*replace shooting_county=1 if birth_county==96073
replace shooting_county=1 if birth_county==21111
replace shooting_county=1 if birth_county==12031
replace shooting_county=1 if birth_county==94013
replace shooting_county=1 if birth_county==34003
replace shooting_county=1 if birth_county==48027
replace shooting_county=1 if birth_county==19103
replace shooting_county=1 if birth_county==26125
replace shooting_county=1 if birth_county==96115
replace shooting_county=1 if birth_county==36097
replace shooting_county=1 if birth_county==25003
replace shooting_county=1 if birth_county==26163
replace shooting_county=1 if birth_county==96059
replace shooting_county=1 if birth_county==96075
replace shooting_county=1 if birth_county==49057
replace shooting_county=1 if birth_county==37051
replace shooting_county=1 if birth_county==56033
replace shooting_county=1 if birth_county==36059
replace shooting_county=1 if birth_county==26161
replace shooting_county=1 if birth_county==21015
replace shooting_county=1 if birth_county==53063
replace shooting_county=1 if birth_county==39085
replace shooting_county=1 if birth_county==25021
replace shooting_county=1 if birth_county==37135
```

```
replace shooting_county=1 if birth_county==34013
replace shooting_county=1 if birth_county==47055
replace shooting_county=1 if birth_county==53025
replace shooting_county=1 if birth_county==12011
*replace shooting_county=1 if birth_county==96073
replace shooting_county=1 if birth_county==92050
replace shooting_county=1 if birth_county==45003
replace shooting_county=1 if birth_county==28121
replace shooting_county=1 if birth_county==21145
*replace shooting_county=1 if birth_county==96059
replace shooting_county=1 if birth_county==55079
replace shooting_county=1 if birth_county==99003
replace shooting_county=1 if birth_county==95031
replace shooting_county=1 if birth_county==42049
replace shooting_county=1 if birth_county==41039
replace shooting_county=1 if birth_county==96065
replace shooting_county=1 if birth_county==13247
*replace shooting_county=1 if birth_county==13121
replace shooting_county=1 if birth_county==15003
replace shooting_county=1 if birth_county==12057
*replace shooting_county=1 if birth_county==17031
*replace shooting_county=1 if birth_county==96073
replace shooting_county=1 if birth_county==51027
replace shooting_county=1 if birth_county==94019
keep if shooting_county==1
save CDC_1982-2002_FINAL, replace

clear
use CDC_1982-2002_FINAL
drop if birth_county==32003 & birth_year!=1982
drop if birth_county==12086 & birth_year!=1982
drop if birth_county==53033 & birth_year!=1983
drop if birth_county==45037 & birth_year!=1983
drop if birth_county==96037 & birth_year!=1984
drop if birth_county==48113 & birth_year!=1984
drop if birth_county==96073 & birth_year!=1984
drop if birth_county==20173 & birth_year!=1985
drop if birth_county==13121 & birth_year!=1985
drop if birth_county==36047 & birth_year!=1986
drop if birth_county==40109 & birth_year!=1986
drop if birth_county==30027 & birth_year!=1986
drop if birth_county==12009 & birth_year!=1987
drop if birth_county==12103 & birth_year!=1988
drop if birth_county==96085 & birth_year!=1988
*drop if birth_county==17031 & birth_year!=1988
*drop if birth_county==17031 & birth_year!=1988
drop if birth_county==45047 & birth_year!=1988
drop if birth_county==22071 & birth_year!=1988
drop if birth_county==96077 & birth_year!=1989
*drop if birth_county==96073 & birth_year!=1989
drop if birth_county==21111 & birth_year!=1989
```

```
drop if birth_county==12031 & birth_year!=1990
drop if birth_county==94013 & birth_year!=1991
drop if birth_county==34003 & birth_year!=1991
drop if birth_county==48027 & birth_year!=1991
drop if birth_county==19103 & birth_year!=1991
drop if birth_county==26125 & birth_year!=1991
drop if birth_county==96115 & birth_year!=1992
drop if birth_county==36097 & birth_year!=1992
drop if birth_county==25003 & birth_year!=1992
drop if birth_county==26163 & birth_year!=1993
*drop if birth_county==96059 & birth_year!=1993
drop if birth_county==96075 & birth_year!=1993
drop if birth_county==49057 & birth_year!=1993
drop if birth_county==37051 & birth_year!=1993
drop if birth_county==56033 & birth_year!=1993
drop if birth_county==36059 & birth_year!=1993
drop if birth_county==26161 & birth_year!=1993
drop if birth_county==21015 & birth_year!=1994
drop if birth_county==53063 & birth_year!=1994
drop if birth_county==39085 & birth_year!=1994
drop if birth_county==25021 & birth_year!=1994
drop if birth_county==37135 & birth_year!=1995
drop if birth_county==34013 & birth_year!=1995
drop if birth_county==47055 & birth_year!=1995
drop if birth_county==53025 & birth_year!=1996
drop if birth_county==12011 & birth_year!=1996
*drop if birth_county==96073 & birth_year!=1996
drop if birth_county==92050 & birth_year!=1997
drop if birth_county==45003 & birth_year!=1997
drop if birth_county==28121 & birth_year!=1997
drop if birth_county==21145 & birth_year!=1997
*drop if birth_county==96059 & birth_year!=1997
drop if birth_county==55079 & birth_year!=1997
drop if birth_county==99003 & birth_year!=1998
drop if birth_county==95031 & birth_year!=1998
drop if birth_county==42049 & birth_year!=1998
drop if birth_county==41039 & birth_year!=1998
drop if birth_county==96065 & birth_year!=1998
drop if birth_county==13247 & birth_year!=1999
*drop if birth_county==13121 & birth_year!=1999
drop if birth_county==15003 & birth_year!=1999
drop if birth_county==12057 & birth_year!=1999
*drop if birth_county==17031 & birth_year!=2001
*drop if birth_county==96073 & birth_year!=2001
drop if birth_county==51027 & birth_year!=2002
drop if birth_county==94019 & birth_year!=2002
save CDC_1982-2002_FINAL, replace

/*Now that the CDC data have been appended and cleaned, the shooting dataset has to
be cleaned as well to match the CDC dataset */
```

```
clear
insheet using Shooting_Data.csv
duplicates list birth_county
duplicates drop birth_county, force
sort birth_county
save Shooting_Data, replace

* Search for duplicates in the shooting database. "duplicates list county month year"
* Make sure you have 3 matching variable names for County, Month, and Year, across the
* shootings dataset and the births dataset.
* Sort both datasets by the three key indicator variables, i.e., County, Month, Year.
* Many-to-1 merge: merge m:1 county month year using Shootings_Data
* Need to convert shootings data into Stata format

clear
use CDC_1982-2002_FINAL
sort birth_county
merge m:1 birth_county using Shooting_Data
drop _merge
save CDC_1982-2002_MergedbyCounty, replace
*Tell Stata: If the date of the shooting is later than the date of birth, baby is unexposed.
*If the date of the shooting is before the date of birth, baby is potentially exposed.
*If the date of the shooting is within 9 months of the date of birth, baby is exposed.
generate birth_date=mdy(birth_month, 1, birth_year)
format birth_date %td

generate shooting_date=mdy(shooting_month, 1, shooting_year)
format shooting_date %td

gen between=shooting_date-birth_date
generate exposed=.
replace exposed=0 if between>0
replace exposed=1 if between<=0
replace exposed=0 if between<=-280

save Case_Control_Full, replace

generate birthwt_new=0
replace birthwt_new=1 if birthwt<=1500
replace birthwt_new=3 if birthwt>=2500

generate mage_new=0
replace mage_new=1 if mat_age<=30
replace mage_new=2 if mat_age>=31

generate plural_new=0
replace plural_new=1 if plural==1
replace plural_new=2 if plural>=2

generate birth_ord_new=0
replace birth_ord_new=1 if birth_ord==1
replace birth_ord_new=2 if birth_ord>=2 & birth_ord!=99
```

```
generate meduc_new=0
replace meduc_new=1 if mat_educ<=12
replace meduc_new=2 if mat_educ>=13 & mat_educ!=99

generate marry_new=0
replace marry_new=1 if marital_stat==1
replace marry_new=2 if marital_stat==2

drop if smoking==99
generate smoking_new=0
replace smoking_new=1 if smoking==0
replace smoking_new=2 if smoking>=1

* Fig 2.
separate birthwt, by(exposed)
twoway  (lpolyci birthwt0 birth_month, lpattern(solid))          ///
                (lpolyci birthwt1 birth_month, lpattern(dash)),          ///
                legend(on) scheme(sj) ///
                title("Birth weight split by shooting exposure", size(small)) ///
                ytitle("Birth weight (g)" " ", size(small)) ///
                xtitle("Month of birth", size(small)) ///
                name(Birthweight_by_ShootingExposure, replace)
graph export Birthweight_by_ShootingExposure.emf, replace

drop birthwt1 birthwt2
separate birthwt, by(sex)
twoway  (lpolyci birthwt1 birth_month, lpattern(solid))          ///
                (lpolyci birthwt2 birth_month, lpattern(dash)),          ///
                legend(on) scheme(sj) ///
                title("Birth weight split by sex of child", size(small)) ///
                ytitle("Birth weight (g)" " ", size(small)) ///
                xtitle("Month of birth", size(small)) ///
                name(Birthweight_by_BabySex, replace)
graph export Birthweight_by_BabySex.emf, replace

drop birthwt1 birthwt2
separate birthwt, by(mage_new)
twoway  (lpolyci birthwt1 birth_month, lpattern(solid))          ///
                (lpolyci birthwt2 birth_month, lpattern(dash)),          ///
                legend(on) scheme(sj) ///
                title("Birth weight split by sex of child", size(small)) ///
                ytitle("Birth weight (g)" " ", size(small)) ///
                xtitle("Month of birth", size(small)) ///
                name(Birthweight_by_BabySex, replace)
graph export Birthweight_by_BabySex.emf, replace

drop birthwt0 birthwt1 birthwt2
separate birthwt, by(plural_new)
twoway  (lpolyci birthwt1 birth_month, lpattern(solid))          ///
                (lpolyci birthwt2 birth_month, lpattern(dash)),          ///
```

```
                legend(on) scheme(sj) ///
                title("Birth weight split by plurality", size(small)) ///
                ytitle("Birth weight (g)" " ", size(small)) ///
                xtitle("Month of birth", size(small)) ///
                name(Birthweight_by_Plural, replace)
graph export Birthweight_by_Plural.emf, replace

use Case_Control
separate birthwt, by(birth_ord_new)
twoway  (lpolyci birthwt1 birth_month, lpattern(solid))         ///
                (lpolyci birthwt2 birth_month, lpattern(dash)),         ///
                legend(on) scheme(sj) ///
                title("Birth weight split by birth order", size(medium large)) ///
                ytitle("Birth weight (g)" " ", size(small)) ///
                xtitle("Month of birth", size(small)) ///
                name(Birthweight_by_order, replace)
graph export Birthweight_by_order.emf, replace

separate birthwt, by(meduc_new)
twoway  (lpolyci birthwt1 birth_month, lpattern(solid))         ///
                (lpolyci birthwt2 birth_month, lpattern(dash)),         ///
                legend(on) scheme(sj) ///
                title("Birth weight split by maternal education", size(medium large)) ///
                ytitle("Birth weight (g)" " ", size(small)) ///
                xtitle("Month of birth", size(small)) ///
                name(Birthweight_by_Mateduc, replace)
graph export Birthweight_by_Mateduc.emf, replace

separate birthwt, by(marry_new)
twoway  (lpolyci birthwt1 birth_month, lpattern(solid))         ///
                (lpolyci birthwt2 birth_month, lpattern(dash)),         ///
                legend(on) scheme(sj) ///
                title("Birth weight split by marital status", size(medium large)) ///
                ytitle("Birth weight (g)" " ", size(small)) ///
                xtitle("Month of birth", size(small)) ///
                name(Birthweight_by_Marriage, replace)
graph export Birthweight_by_Marriage.emf, replace

separate birthwt, by(smoking_new)
twoway  (lpolyci birthwt1 birth_month, lpattern(solid))         ///
                (lpolyci birthwt2 birth_month, lpattern(dash)),         ///
                legend(on) scheme(sj) ///
                title("Birth weight split by smoking", size(medium large)) ///
                ytitle("Birth weight (g)" " ", size(small)) ///
                xtitle("Month of birth", size(small)) ///
                name(Birthweight_by_smoking, replace)
graph export Birthweight_by_smoking.emf, replace

clear
use Case_Control_Full
replace sex=0 if sex==1
```

```
replace sex=1 if sex==2

replace birth_ord=0 if birth_ord==1
replace birth_ord=1 if birth_ord!=0

replace birth_attend=0 if birth_attend==1
replace birth_attend=0 if birth_attend==2
replace birth_attend=1 if birth_attend!=0

replace mat_race=0 if mat_race==1
replace mat_race=1 if mat_race!=0

replace wt_gain=. if wt_gain==99
replace wt_gain=1 if wt_gain==0
replace wt_gain=0 if wt_gain==25
replace wt_gain=0 if wt_gain==26
replace wt_gain=0 if wt_gain==27
replace wt_gain=0 if wt_gain==28
replace wt_gain=0 if wt_gain==29
replace wt_gain=0 if wt_gain==30
replace wt_gain=0 if wt_gain==31
replace wt_gain=0 if wt_gain==32
replace wt_gain=0 if wt_gain==33
replace wt_gain=0 if wt_gain==34
replace wt_gain=0 if wt_gain==35
replace wt_gain=0 if wt_gain==36
replace wt_gain=0 if wt_gain==37
replace wt_gain=0 if wt_gain==38
replace wt_gain=0 if wt_gain==39
replace wt_gain=0 if wt_gain==40
replace wt_gain=1 if wt_gain!=0

replace mat_educ=. if mat_educ==99
replace mat_educ=1 if mat_educ==0
replace mat_educ=0 if mat_educ==13
replace mat_educ=0 if mat_educ==14
replace mat_educ=0 if mat_educ==15
replace mat_educ=0 if mat_educ==16
replace mat_educ=0 if mat_educ==17
replace mat_educ=1 if mat_educ!=0

replace marital_stat=. if marital_stat==9
replace marital_stat=0 if marital_stat==1
replace marital_stat=1 if marital_stat==2

replace gestat=. if gestat==99
replace gestat=0 if gestat==38
replace gestat=0 if gestat==39
replace gestat=0 if gestat==40
replace gestat=0 if gestat==41
replace gestat=0 if gestat==42
```

```
replace gestat=1 if gestat!=0

replace apgar_5=. if apgar_5==99
replace apgar_5=0 if apgar_5==6
replace apgar_5=0 if apgar_5==7
replace apgar_5=0 if apgar_5==8
replace apgar_5=0 if apgar_5==9
replace apgar_5=0 if apgar_5==10
replace apgar_5=1 if apgar_5!=0

replace smoking=1 if smoking!=0
replace smoking=. if smoking==99

replace plural=0 if plural==1
replace plural=1 if plural!=0

replace prenat_visit=. if prenat_visit==99
replace prenat_visit=0 if prenat_visit==10
replace prenat_visit=0 if prenat_visit==11
replace prenat_visit=0 if prenat_visit==12
replace prenat_visit=0 if prenat_visit==13
replace prenat_visit=0 if prenat_visit==14
replace prenat_visit=0 if prenat_visit==15
replace prenat_visit=1 if prenat_visit!=0
save Case_Control_Full, replace

replace military_experience=0 if military_experience==1
replace military_experience=1 if military_experience==2

*make-sure you can make automated tables
ssc install estout, replace

*Tables 1&2: Summary statistics (mean, standard deviation, observations, etc.), for both CDC
data and for shooting data

*Table 3: Regression results (perhaps with 4 versions of a regression model)
* Normal multivariable regression
reg birthwt exposed sex birth_month birth_year gestat birth_ord mat_age mat_race wt_gain
apgar_5 plural
eststo model_1
reg birthwt exposed marital_stat mat_educ smoking birth_county birth_attend prenat_visit
eststo model_2
reg birthwt exposed totalnumberofguns c.totalnumberofguns#i.exposed military_experience
c.military_experience#i.exposed possiblemotive c.possiblemotive#i.exposed
relationshiptoincidentlocation c.relationshiptoincidentlocation#i.exposed totalnumberofvictims
c.totalnumberofvictims#i.exposed
eststo model_3
reg birthwt exposed sex birth_month birth_year gestat birth_ord mat_age mat_race wt_gain
apgar_5 plural marital_stat mat_educ smoking birth_county birth_attend prenat_visit
totalnumberofguns c.totalnumberofguns#i.exposed military_experience
c.military_experience#i.exposed possiblemotive c.possiblemotive#i.exposed
```

```
relationshiptoincidentlocation c.relationshiptoincidentlocation#i.exposed totalnumberofvictims
c.totalnumberofvictims#i.exposed
eststo model_4
esttab  using Comp_Results_316.rtf, p r2 mtitles b(%9.3f) label starlevels(* .10 ** .05 *** .01)
        ///
                sfmt(%9.3f %9.0f %9.3f) title(Results addnotes(Note: Put your notes here))
replace
eststo clear
```